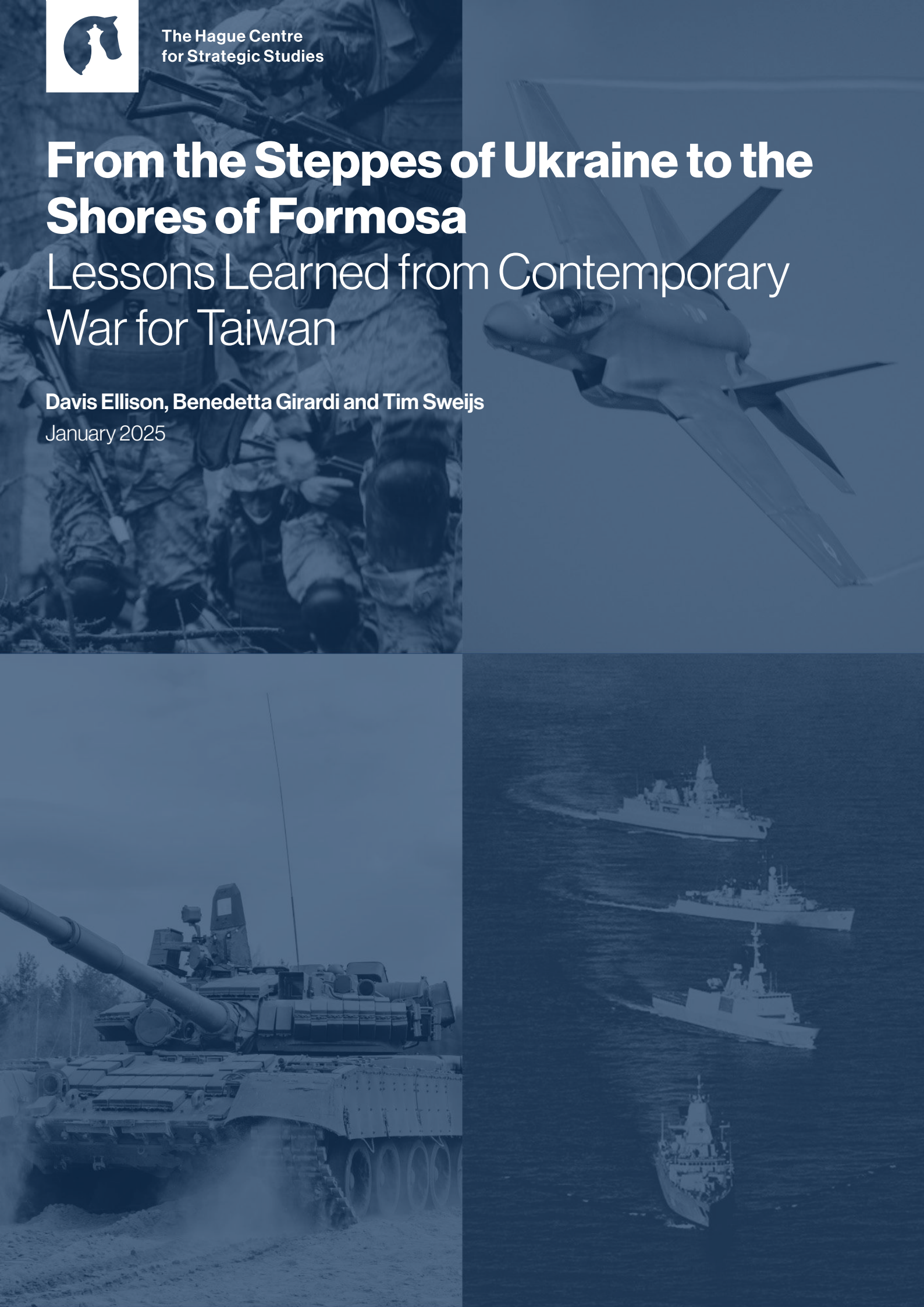

The Hague Centre
for Strategic Studies

From the Steppes of Ukraine to the Shores of Formosa

Lessons Learned from Contemporary War for Taiwan

Davis Ellison, Benedetta Girardi and Tim Sweijs

January 2025

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Executive Summary

Are the lessons drawn from the ongoing Russian war against Ukraine applicable to a possible invasion of Taiwan by the People's Republic of China (PRC)? Applying lessons from one conflict to another is a tricky business. Such exercises typically result in lessons that are either so generic as to verge towards the trite or so specific to lack any applicability outside of the case in question. This study then treads a fine line. It identifies lessons from Ukraine for the general application of military force and then considers which lessons are sufficiently specific to be meaningfully transposable from the Ukrainian theatre of war to the hypothetical Taiwanese one.

This study focuses on four main areas: command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR), and the land, air and maritime domains. Each chapter employs a campaign analysis approach to identify lessons for these four areas considering different stages of the campaign: Invasion and its repellence (Feb-July 2022); Consolidated defence (Aug-Feb 2023); Counterattack (Mar-Sept 2023); and Stalemate (October 2023-November 2024). Both the Russian and Ukrainian sides of the conflict are reflected on along these four stages to identify the interrelated offender and defender dynamics. A campaign analysis reflects this dynamism.

One of the most important reminders from the Russian invasion of Ukraine for the wider analytical community is that pre-war assessments must be continually revisited and updated as new information comes in and all sides adapt to battlefield conditions and shifting political dynamics.

The campaign analysis specifically considers those developments at the military-operational level. As such, it seeks to distil insights that inform choices pertaining to posture, preparedness, strategy and doctrine, platforms and organisation but always with a clear and direct link to the level of military operations.

This Executive Summary limits itself to the main conclusions and recommendations for Taiwan based on the findings of the campaign analysis itself which is provided in Chapter 2-5 and the implications of these findings – the 'lessons' - for a contingency over Taiwan, which are discussed in Chapter 6.

Our analysis yields two overarching conclusions. First, Ukraine's defence has highlighted across domains that a denial strategy remains the most likely successful path of resistance against a PLA attack. The objective of a denial strategy is to frustrate the PRC's invading military forces by preventing them from using and exploiting their strengths in the land, air, and maritime domains. As a result, a denial strategy increases the cost of aggression directly before, during, and after a possible PRC invasion. A Taiwanese denial strategy is rooted in a force posture aimed at denying a PRC invasion force the ability to achieve a swift victory. It is rooted in a resilient society and a military that can withstand strikes and still operate, whilst targeting and weakening the adversary's forces. It is unlikely that Taiwan will be able to survive for a longer period without support. A denial strategy therefore seeks to prevent the PRC quick military victory, significantly raise the costs of an invasion attempt, and create a situation in which external supporters can come to Taiwan's aid.

To achieve denial, Taiwan should further pursue capabilities that adhere to multiple denial logics, including operational paralysis, tactical degradation and strategic effect reduction. Taiwan's force posture based on a denial strategy should be increasingly asymmetric in nature. To a degree, conflicts are always asymmetric in nature as opponents seek to exploit advantages where they benefit from asymmetry. The term here, however, explicitly conveys the notion that Taiwan can no longer afford to go toe-to-toe with the PRC in terms of conventional advanced military capabilities because it is severely outmatched if not in quality then definitely in sheer numbers. It should therefore seek other ways to balance the PRC's power preponderance by leveraging asymmetric advantages. Crucially, an asymmetric denial strategy can inform an overall Taiwanese force posture, serve as a unifying element to guide the development of doctrine, the acquisition of capabilities, and the joint training and exercising of services, thereby guiding overall war preparation efforts. This proposal and its constituent elements are far from revolutionary and have been proposed as guiding concepts in recent years. It is now critical to double down on these efforts.

A second overarching conclusion is that quality can indeed overcome quantity, but only to a point. The relative value of quantity increases as conflict persists. Sustainment, mobilisation, production, and defence against persistent strikes comes to outweigh the value of very specific platforms that are only available in limited quantity. Maintaining these functions in the face of longer blockades or sustained assaults is also important for morale, as individual and small unit cohesion can only take so much without support. Ukraine has faced a large state operating under war economy conditions, and without foreign assistance would have simply been out-produced and out-mobilised through sheer numbers. For Taiwan and its international backers, this is an important point. Sustaining defence in the longer term while under heavy attack is difficult. Doing so on an island far from its main partners is even more difficult. As part of giving teeth to an asymmetric denial strategy, Taiwan will need to prioritise voluminous and disposable assets that can be swiftly replaced at lower cost than highly advanced, extremely expensive, multirole platforms, and, at least in part, produced on the island itself.

Among the three levels of command, communication, and intelligence, a few areas of development stand out. First, regarding the command level, preparedness and coordination between civil-military and inter-service spheres are essential as well as effective mission command chains. Second, improvements in command control and communication technologies need to target an increased level of connectivity between both civilian and military stakeholders to prevent any major disruptions within the population and battlefield. Lastly, information flows through drones and electronic intelligence are critical to guarantee robust, survivable, and adaptable intelligence.

By domain, there are certain capability investments that are either already programmed or should be added to planned modernisation efforts. ISR assets, drones across classes, anti-ship and land-attack missiles, counter-drone electronic warfare, and mines are all capability investments that will bolster a denial posture. Sustainment of each, training of personnel, and exercising realistic scenarios is needed across areas. By leveraging as much of these lessons as possible, Taiwan can learn from Ukraine and harden itself enough to deter an attack and to counter one should it come.

Going by area covered in this report, the Ukrainian experience yields the following recommended areas of focus for Taiwan:

In C4ISR, the Ukrainian experience yields the following recommendations for Taiwan:

- **Ensure coherency in service-specific and joint command structures.** Guarding against 'stove-piped' command channels and against inter-service rivalries impacting operational effectiveness is essential. This requires pre-war discussions and exercises within and between service leadership teams to practice command and control arrangements under realistic wartime conditions.
- **Building and maintaining resilient communications systems with back-ups.** Being able to communicate amongst forces, to the public, and to the outside world is vital before and throughout conflict. Resilient communications systems, with back-ups outside the country, and ideally a combination of terrestrial and space-based, are needed. Importantly, this necessitates a well-resourced cyber defence and counter-EW effort.
- **Guard against dysfunction in the intelligence enterprise.** Competing organisations, mixed signals, and poor analysis are the ingredients for intelligence disaster. Divisions between various intelligence entities should be broken down as much as feasible, while dissent and frank discussion amongst intelligence collectors, analysts and decision makers should be fostered.
- **Invest in the proliferation of sensors.** Investing in drones of all classes and sizes, equipping units across services with them, and leveraging the wide availability of commercial data is essential for tasks ranging from pre-war collection to target acquisition. This capability should be maintained with as much independence as possible, to guard against over-reliance on foreign intelligence provision.

On land, the following lessons for Taiwan can be identified:

- **Forge layered defence networks.** Leveraging Taiwan's unique geography, the Taiwanese land forces can make the PLA's job incredibly difficult. From immediate defences on the outlying islands, from hardened areas around sea and air landing sites, urban areas, and finally the mountains, the island can accommodate several layers of engineered defensive fortifications and infrastructure. The land forces would have a central role in building and manning these layers of defences.
- **Increase battlefield transparency.** A consistent theme across domains, the integration of drones of various sizes into land operations is a trend that has emerged in conflicts across the globe. For ground forces, this includes enabling troops at the fire team (4 or so soldiers) to the squad level with tactical mini-drones and scaling upwards for company- and brigade-level units to be supported by larger ISR capabilities such as MQ-9 Reapers.
- **Establish robust logistical chains.** The ground forces will have an important role to play in sustaining forces across the island in a range of scenarios. Ensuring redundant capacity across the range of combat support services (CSS) ranging from transport, storage, medical, maintenance, and engineering support will become the backbone of the armed forces in a more sustained campaign. Investment in CSS should further be based on the logic of redundant capacity, rather than "just in time" logistics. Attrition in the face of PLA attacks, given that strikes would certainly target logistics capacity, should be a factor in developing planning targets.

In the air, the ongoing war yields the following lessons:

- **Build up Integrated Air and Missile Defence (IAMD).** For Taiwan, as has been the case in Ukraine, highly capable IAMD with huge capacity is required not only to protect vital military facilities and forces but also to ensure civilians are protected and the government can continue to function. Maintaining a large number of Sky Bow, Strong Bow, and Patriot systems with a redundant mass of interceptors demands significant and sustained investments. This investment is core to the strategy and attendant operating concepts of denial.
- **Develop and acquire drones.** Commercial grade and military grade drones that are disposable, voluminous and relatively cheap and that can be in part produced on the island itself will provide an important enabler for ISR purposes and can be used for targeting and strike purposes in the defence of the island.
- **Develop and acquire counter-drone capabilities.** Heavy People's Liberation Army (PLA) investments in drones that would be coupled with missile strikes to degrade IAMD necessitate a counterinvestment in counter-drone technologies. This includes both kinetic interception and non-kinetic electronic warfare assets. Non-kinetic assets, including a line of site C-UAS 'guns' for smaller units, and larger space-enabled assets at dedicated electronic warfare sites. Coupling these sites with larger IAMD nodes guards against combined drone and missile strikes. The placing of these sites is of course a sensitive choice, balancing between civilian protection and military force protection.

At sea, we identify the following lessons for Taiwan:

- **Invest in naval strike capabilities.** Naval strike missiles, both AShMs and LACMs, will be important assets for both larger platforms and marine forces to have both capability and capacity. Mobile strike platforms enabled with these longer-range assets will be important to countering any attempted landings and stalling advances in the outlying islands. In denying the Taiwan Strait to the People's Liberation Army Navy (PLA-N), the Republic of China Navy (ROCN) will play a lynchpin role in a denial strategy.
- **Develop and acquire drones.** The Ukrainian raids on the Black Sea fleet in Crimea showed the capability of using combined USV and UAV attacks to remove any safe havens for naval assets. Possible PLA staging areas such as the PLA-N Fujian Base on Xiamen Island would be particularly vulnerable to persistent raiding in any ROCN counterattacks. The further afield the PLA-N is forced to base sensitive assets, the less likely an amphibious attack can succeed. Further, unmanned underwater vehicles (UUVs) can be used in a denial role as well, filling the Strait with many, stealthy 'suicide UUVs' making any crossing increasingly prohibitive.
- **Develop mine warfare capabilities.** Like UUVs, mines in the Taiwanese littoral, especially around possible landing beaches and ports, will contribute to denying the PLA a beachhead. Of course, pre-emptive deployments of such weapons in peacetime are difficult economically and are a risk to civilian areas. Therefore, the capability to quickly deploy mines at scale is needed, whether air or sea delivered. De-mining capabilities are needed as well, as port infrastructure must be maintained in longer-term scenarios.

1. Introduction

Are lessons drawn from Russia's war against Ukraine applicable to a possible invasion of Taiwan by the People's Republic of China (PRC)? Applying lessons from one conflict to another is a tricky business. Such exercises typically result in lessons that are either so generic as to verge towards the trite (i.e., air power is important) or so specific to lack any applicability outside of the case in question ((i.e., the impact of British light weapons training for Ukrainian ground forces). This study then treads a fine line. It identifies lessons from Ukraine for the general application of military force and then considers which are sufficiently specific to be meaningfully transposable from the Ukrainian theatre of war to the hypothetical Taiwanese one.

This study focuses on four main areas: command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR), the air domain, the maritime domain, and the land domain. Each chapter employs a campaign analysis approach to identify lessons for these four areas considering four different stages of the campaign: Invasion and its repellence (Feb-July 2022); Consolidated defence (Aug-Feb 2023); Counterattack (Mar-Sept 2023); Stalemate (October 2023-November 2024). The campaign analysis specifically considers those developments most relevant for a possible attempted People's Liberation Army (PLA) invasion of Taiwan at the military-operational level. As such, it seeks to distil insights that inform choices pertaining to posture, preparedness, strategy and doctrine, organisation and assets but always derived from the level of military operations. In line with Allan Reed Millet and Williamson Murray's denotation, the military operational level 'involves the analysis, planning, preparation, and conduct of [..] campaign[s]', which includes the 'disposition and marshalling of military units, the selection of theatre objectives, the arrangement of logistical support, and the direction of ground, air and sea forces', complemented, thirty five years later, with potential cyber and space forces.[1]

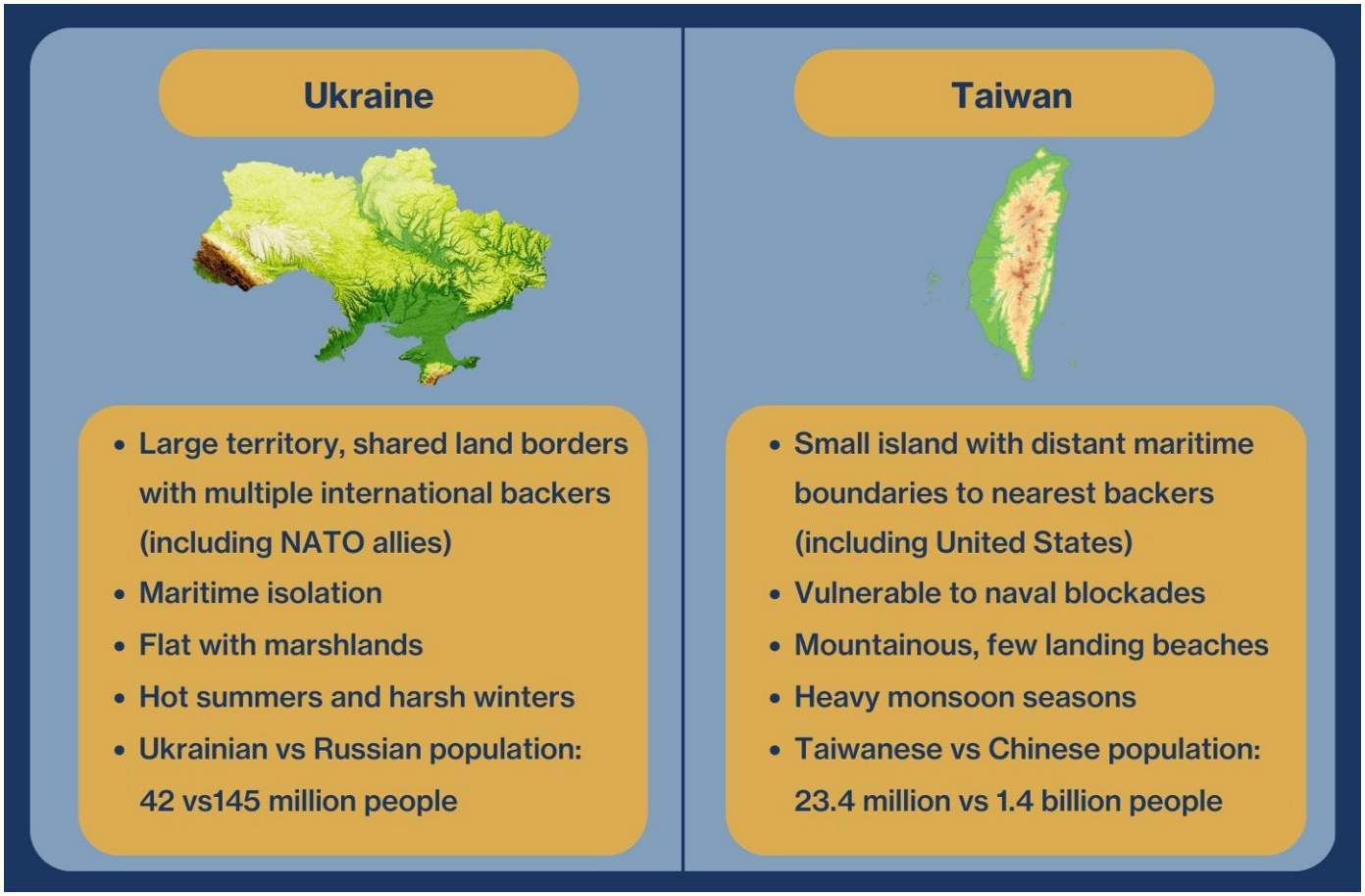
This report also highlights that while lessons may be considered applicable, they are not seen as immediately transferable due to differences in the geography, international constellation, and military-strategic dynamics associated with the two theatres.[2] The two theatres differ massively in their geographical makeup. Ukraine features a vast and relatively flat territory, sharing borders both with Russia and NATO members, and an extended coastline, opening it up to many different attack vectors but also making (re)supply efforts easier. Taiwan is a mountainous island state roughly 160 kilometres from the Chinese coast. The PRC will have to invade from the sea and the air which may be easier to defend against. Yet, the PRC can also encircle Taiwan and Taiwan's insular status will make it much more difficult to resupply it in case of a war. Ukraine has a relatively larger indigenous defence industrial capacity to build on compared to Taiwan. Meteorological conditions also vary greatly. Ukraine experiences a temperate climate with cold winters and hot summers, and its vast open plains are prone to seasonal mud. Taiwan, on the other hand, has a subtropical climate with high humidity,

1 Allan Reed Millett and Williamson Murray, *Military Effectiveness. Volume 1, The First World War*, vol. 1 (Boston: Unwin Hyman, 1988), 12; For a critique of the utility of an 'operational level of war', see Justin Brigadier Kelly and Michael James Brennan, *Alien: How Operational Art Devoured Strategy* (US Army War College Press, 2009), http://archive.org/details/AlienHowOperationalArtDevouredStrategy.

2 See also Tim Sweijs and Jeff Michaels, Introduction, in Tim Sweijs and Jeff Michaels (eds.), Beyond Ukraine Debating the Future of War, Hurst/Oxford University Press 2024, esp. pp. 3-9. https://academic.oup.com/book/58940/chapter-abstract/492982824?redirectedFrom=fulltext

frequent rainfall, and typhoons, with a monsoon season that restricts attack opportunities on the island to April and October-November. In both cases, the demographic imbalance between the parties massively favours the attacker but in the case of China and Taiwan with a factor of fifty rather than a factor of five as in the case of Russia and Ukraine. In any case, given the different strategic challenges, the two nations will also have vastly different military-operational needs, both to prepare for a war to stave off an attack, and during a war in case of invasion, but also, in a potential contingency over Taiwan, in case of a quarantine. Figure 1 below summarises the geographical, meteorological, and demographic differences between Ukraine and Taiwan.

Figure 1. Geographical, meteorological, and demographic differences between Ukraine and Taiwan



A recent study by the Centre for Strategic and International Studies (CSIS) led by Eliot Cohen, Phillips O'Brien, and featuring a wonderful introduction by Hew Strachan, has found serious analytical failures by the military and intelligence expert communities both in and outside governments in the run-up to the 2022 Russian invasion of Ukraine.[3] Among other mistakes, the authors identify an overreliance on numerical data ('bean counting'), an underestimation

[3] Eliot A. Cohen, Phillips O'Brien, and Hew Strachan, 'The Russia-Ukraine War: A Study in Analytic Failure', *The Centre for Strategic and International Studies*, 24 September 2024, https://www.csis.org/analysis/russia-ukraine-war-study-analytic-failure.

of non-quantitative factors (training and morale), a dismissive attitude towards the combat experience of the Ukrainian forces between 2014 and 2022, and a neglect of the wider political and social factors present in both Ukraine and Russia.[4] This led to a general pre-war expectation that Ukraine would fall quickly (with some assessments predicting within 72 hours) and that the Russian armed forces would 'steamroll' the Ukrainian military. It is with this precedent in mind that we approach the central issue at hand with humility while incorporating context beyond the immediate battlefield when considering a possible war between the PRC and Taiwan.

Furthermore, we note that while much of the Western analytical community has been closely watching the Russian invasion, so has the PLA. With an aim to avoid the failures of the Russian armed forces in the early stages of the invasion, PRC analysts have already identified that "due to communication command and logistics support problems, and underestimation of the enemy" Moscow was unable to achieve its early maximalist goals of regime change and a short 'special military operation'.[5] Further, analyses from different PRC institutes note that the role of foreign support for Ukraine has been crucial, and that without the substantial military, intelligence, and financial aid provided it would have been difficult for Ukraine to maintain its defence until the time of writing.[6] It is quite likely that the PLA has at least recognised the risks inherent in assumptions associated with a short war fallacy against Taiwan, has identified foreign support as a major centre of gravity for the defence, and has paid due attention to C4ISR and logistics support in their thinking. There is of course just as much room for analytical failure in Beijing as anywhere else, though this can hardly be a planning consideration for Taipei or its backers.

In each section of this study, we provide necessary background information where relevant to ensure that pre-war developments are adequately considered. Particularly in the Chapter on C4ISR, the preceding years of intelligence preparation and analysis by both Ukraine and Russia are considered, to include the role of foreign-supplied information. Both Ukraine and Russia could build on years of pre-war military development, leveraging operational experience against one another as well as in the case of Russia, in other theatres, especially in the Middle East and Africa. The early phases of the Russian invasion then put both these modernisation programmes and the pre-war analytical presumptions to test. Monitoring the performance of these programmes through the early phases is useful in that both Taiwan and the PRC are undergoing military modernisation programmes as well. A major difference to note, however, is the general lack of direct combat experience on both sides of the Taiwan Strait, though both Taiwan and the PRC have a great deal of experience against one another when it comes to mobilisation, coercion, and intelligence operations.

A final note to this introduction is to stress that the campaign analysis approach was chosen to reflect the dynamism of the conflict. Perhaps one of the largest reminders from the Russian invasion of Ukraine for the wider analytical community is that pre-war assessments must be continually revisited and updated as new information comes in and all sides adapt to battlefield conditions and shifting political dynamics, as Mick Ryan reminds us in his insightful analysis of 'adaptation under fire' in 'The War for Ukraine'.[7] This means there is an overall caveat to

4 Ibid., 43-46.

5 Xiangying Ouyang and Yuxin Zhang, 'Analysis of Uncertainties Affecting the Russia-Ukraine Conflict [影响俄乌冲突走向的不确定因素分析]' (The Centre for Strategic and International Studies Interpreter, 1 December 2023), 9, https://interpret.csis.org/translations/analysis-of-uncertainties-affecting-the-russia-ukraine-conflict/.

6 Evan Medeiros et al., 'Chinese Assessments of the War in Ukraine, 2 Years On', Interpret: China, 11 June 2024, https://interpret.csis.org/chinese-assessments-of-the-war-in-ukraine-2-years-on/.

7 Mick Ryan, *The War for Ukraine: Strategy and Adaptation Under Fire*, 2024, https://www.usni.org/press/books/war-ukraine.

this study that pre-war implications as applied to a Taiwan-PRC conflict will be imperfect, and that equal study is required to explore how both Taipei and Beijing adapt under pressure.

Given budgetary and temporal constraints, this study predominantly utilises desk research including the consultation of primary and secondary sources. Over the past few years, a steady stream of insightful analyses in official and think tank studies has been published that the research team could draw on to identify lessons. Reports that have been based on field visits to Ukraine itself have been heavily used. Desk research was complemented by a field trip of the research team to Taiwan for background and off-the-record talks with researchers and official representatives.

This study proceeds through four analytical chapters focused on C4ISR and the air, sea, and land domains respectively. It then concludes with a chapter highlighting the most relevant lessons as applicable to Taiwan, synthesising the observations gathered in the preceding four campaign analyses. The conclusion also highlights implications for the Taiwanese armed forces, insights for potential wartime international supporters, and areas for further research.

2. The Battle of C4ISR Systems

War in a strict military sense can be best understood as a struggle between two or more states' defence systems. In the Western model, since at least the 1970s, such systems have revolved around command, control, communications, computers, intelligence, and reconnaissance (C4ISR) networks. This expansive acronym encapsulates the secure networks over which to pass classified communications, intelligence, targeting data, and more, which supports the command-and-control structure that directs the application of armed force.[8] In the build-up leading to and the early phases of an armed conflict, C4ISR provides the advance, early-warning information that allows for general mobilisation, the evacuation of civilians, and the activation of special wartime governmental powers. Failing this, states remain open to a *fait accompli* attack that decides the outcome of a war in its earliest phases, sometimes even before defence systems have fully engaged in battle.[9]

C4ISR is ultimately the backbone that allows militaries to find, target, strike, assess, and retarget the firepower which they wield, on the tactical, operational and strategic levels of war. The wider C4ISR system must be able to answer key questions including: 1) Where are enemy forces and what is their disposition? 2) Has this information been communicated to the correct unit to attack or defend against those forces? 3) Has that unit effectively defeated the enemy forces? 4) If not, what must be readjusted or allocated? and 5) How has the engagement impacted the wider theatre-level battle? While basic and intuitive, the actual answering of these questions in practice is far more difficult and requires enormous investments in both time and money.

American strategist and net assessment guru Andrew Marshall predicted in 1999 that "defeat will occur due to disintegration of command-and-control capacities rather than attrition or annihilation."[10] The Russian invasion of Ukraine has exposed that rather than being antithetical to one another, competing C4ISR systems and attrition warfare can be complementary.[11] C4ISR competition turned out to be less a sudden, decapitating strike against an adversary's networks and command centres than it is a prolonged struggle to shape battlefield conditions, gather and prepare intelligence, adapt command structures to setbacks, and incorporate communications systems that can reduce vulnerabilities.

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8 Davis Ellison and Tim Sweijs, 'HCSS-NATO HQ SACT Symposium Report: Rethinking Fire and Manoeuvre across the Physical and Non-Physical Aspects of Domains' (The Hague: The Hague Centre for Strategic Studies, November 2023), 12–14, https://hcss.nl/wp-content/uploads/2023/11/HCSS-NATO-ACT-Symposium-Report-Rethinking-Fire-and-Manoeuvre-2023.pdf.

9 Dan Altman, 'By Fait Accompli, Not Coercion: How States Wrest Territory from Their Adversaries', *International Studies Quarterly* 61, no. 4 (1 December 2017): 881–91, https://doi.org/10.1093/isq/sqx049.

10 Zalmay Khalilzad and John P. White, *Strategic Appraisal: The Changing Role of Information in Warfare* (Washington, D.C.: RAND Corporation, 1999), 5.

11 Frank Hoffman, 'Defeat Mechanisms in Modern Warfare', *The US Army War College Quarterly: Parameters* 51, no. 4 (17 November 2021): 49–66, https://doi.org/10.55540/0031-1723.3091; Amos C. Fox, 'On Attrition: An Ontology for Warfare', *Military Review*, September 2024, 51–61.

The battle between competing C4ISR systems has been on full display during the Russian invasion of Ukraine. Slightly over three decades ago, the states were still integrated into a single entity and shared a common military force, the Soviet Union's armed forces. The two states have obviously diverged in the intervening decades, with Ukraine in particular undergoing a major, NATO-supported defence transformation after 2014. Russia meanwhile engaged in a series of long-running campaigns against insurgents in Chechnya, Dagestan, and Syria. Russia's invasion of Georgia in 2008 revealed deficiencies that drove its own military transformation. In February 2022, these two newly developed systems collided, exhibiting marked differences between the two parties in terms of approaches to command and control, intelligence apparatuses, and the setup of their communications networks including the technologies underlying these networks.

This chapter examines the performance of three major C4ISR elements in the conduct of the ongoing Russo-Ukrainian war: 1) command and control structures 2) communications and IT and 3) intelligence structures and capabilities.

2.1. The Russian and Ukrainian C4ISR balance prior to February 2022

What C4ISR structures capabilities had Russia and Ukraine developed prior to the 2022 invasion? Answering this question is easier to answer in some areas than others. Information about command structures, for example, can be found relatively easily as both states' basic military organisations are publicly available. Communications networks and intelligence relationships are, unsurprisingly, far opaquer given the secrecy surrounding their functions. Nevertheless, close to three years of warfare have revealed quite a bit.

In short, across the three elements, the primary difference between Russia and Ukraine is the element of flexibility, at least at certain levels. C4ISR, if understood in the wider command and information complex described in the introduction, requires clarity and speed in information collection, processing, dissemination, execution, and feedback along this process, for optimal performance. Generally, Russia's information management and command and control structure has been characterised by rigidity, fear of passing along unwelcome information, and a reluctance on the part of junior officers to take initiative whether in combat or in other areas of military activity. In Ukraine, this has largely been the opposite, where a much lower level of initiative has allowed for more spontaneous planning and action. Additionally, intelligence and assessments appear to be passed along with little hesitancy or interference.[12] The remainder of this section focuses exclusively on Ukrainian intelligence structures, as the period leading up to February 2022 was dominated by a development of the Ukrainian intelligence apparatuses that would come to shape the early phases of the war.

2.1.1. Pre-War Intelligence Structures

Ukraine had the benefit of a significant amount of intelligence preparation and support from external agencies in the years leading up to the Russian invasion. Kyiv's domestic and foreign intelligence services received nearly a decade of direct support from the United States (US)

[12] John Nagl and Katie Crombe, *A Call to Action: Lessons from Ukraine for the Future Force* (Carlisle Barracks, PA: US Army War College Press, 2024), 70–72.

Central Intelligence Agency (CIA) and the British Secret Intelligence Service (MI6), as the Ukrainian government began to rebuild services following the Maidan revolution and the flight of pro-Russian government officials in 2014.[13]

The Ukrainian Ministry of Defence's Main Intelligence Directorate, or HUR, received a particularly significant amount of aid, including the building of communications and listening stations as well as in-person support from American and British intelligence officers. Put by one US senior intelligence official during the war, "Are they pulling triggers? No. Are they helping with targeting? Absolutely."[14] By early 2022, Kyiv and its partners had established a robust all-source intelligence complex across the country and even in Russia itself, which proved crucial in providing indicators and warnings leading up to the invasion of February of that year.[15]

By early 2022, Kyiv and its partners had established a robust all-source intelligence complex across the country and even in Russia itself.

Meanwhile, Russian intelligence had been largely coming apart at the seams. For years, Putin had pitted the various intelligence services and the armed forces against one another to 'coup-proof' the regime.[16] The relationship between the foreign intelligence service, the SVR, and the military intelligence directorate, the GRU, was particularly dysfunctional. Further complicating matters the Russian domestic security service, the FSB, was tasked with the preparation of strategic intelligence to launch the war, rather than the SVR or GRU.[17]

Russian space-based intelligence had been in decline in the lead-up to the war, with Moscow's space industry having suffered heavily from sanctions since 2014. As the war unfolded, Russian forces would come to rely on Iranian space assets to inform some of their targeting. In general, the use of space-based capabilities by the Russian armed forces was particularly limited across applications ranging from precision guidance to communications.[18]

This muddled situation for Russian intelligence, as well as a predilection to tell the Kremlin what it wanted to hear, led to faulty intelligence assessments guiding major decisions, including reportedly, the decision to launch the attack at all. To this, the FSB had been feeding the Kremlin a faulty picture based on poorly conducted surveys of Ukrainians that "Russian forces would be greeted as liberators."[19] This assessment informed the plan for a lightning assault across the country, with a major effort to strike Kyiv, assassinate Zelenskyy and other top officials, and seize control of the government within days. This, of course, did not happen.

13 Adam Entous and Michael Schwirtz, 'The Spy War: How the C.I.A. Secretly Helps Ukraine Fight Putin', *The New York Times*, 25 February 2024, sec. World, https://www.nytimes.com/2024/02/25/world/europe/cia-ukraine-intelligence-russia-war.html.

14 Entous and Schwirtz.

15 Nagl and Crombe, *A Call to Action: Lessons from Ukraine for the Future Force*, 69–83.

16 Adam E. Casey, 'Putin Has Coup-Proofed His Regime', *Foreign Policy* (blog), 23 March 2022, https://foreignpolicy.com/2022/03/23/putin-coup-russian-regime/.

17 'War in Ukraine: One Year On' (London: King's College London Centre for Grand Strategy, February 2023), 17–19, https://www.kcl.ac.uk/warstudies/assets/war-in-ukraine-one-year-on.pdf.

18 Elena Grossfeld, 'Russia's Declining Satellite Reconnaissance Capabilities and Its Implications for Security and International Stability', *International Journal of Intelligence and CounterIntelligence*, 8 May 2024, 1–30, https://doi.org/10.1080/08850607.2024.2330848.

19 Greg Miller and Catherine Belton, 'Russia's Spies Misread Ukraine and Misled Kremlin as War Loomed', The Washington Post, 19 August 2022, https://www.washingtonpost.com/world/interactive/2022/russia-fsb-intelligence-ukraine-war/.

2.2. **Invasion and its repellence** (February – July 2022)

2.2.1. **Command**

The Russian force that invaded Ukraine in February 2022 was what Caitlin Talmadge calls a "dictator's army".[20] Russian President Vladimir Putin had for years engaged in efforts to ensure that the armed forces could not be used in a coup, a not unrealistic fear given that Putin himself witnessed two military interventions in domestic politics in both 1991 (the attempted August coup) and 1993 (the Russian constitutional crisis).

Using Talmadge's work, available information about the pre-war Russian armed forces suggests that:

1. Promotion patterns were largely meritocratic, however;
2. Training regimens for the forces were not sufficiently rigorous, realistic, or frequent;
3. Command arrangements were highly centralised yet also unclear once in theatre;
4. Information was 'stove-piped' both vertically and horizontally.

Each of these factors contributed to Russia's early struggles in the campaign, and their adjustment over time can partly account for how Moscow's fortunes were ultimately reversed up until this writing.

Focusing on promotion patterns, it is noteworthy that at the onset of the war, there was no single field commander who led the 'Special Military Operation.' Rather, the commanders of the respective military districts in which troops were mobilised retained command over those same forces, leading to unclear lines of communication and authority. Additionally, the involvement of Chechen and Wagner Group irregulars in combat further muddled the command environment. It was only in early April 2022 that a single, unified operational commander was put into position, the first being Army General Alexandr Dvornikov. Perhaps counter to expectations, Dvornikov was a meritocratic choice. A recipient of the Hero of Russia award for his brutal operations in Syria on behalf of Russia's ally beginning in 2015, Dvornikov was an obvious pick for command of the unified operation. However, by June 2022 Dvornikov had been relieved to be replaced months later by the longer-serving Sergey Surovikin, though the precise reasons for this replacement remain a mystery.

Overall, the command environment for Russia was chaotic. Formal chains of command were occasionally circumvented by informal chains, particularly by Chechen irregulars under the direct command of their leader Ramzan Kadyrov and Wagner Group mercenaries under the command of Yevgeniy Prigozhin.[21] Above the battalion tactical group (BTG) level, formal Russian command arrangements were characterised by rigidity and bureaucracy, with a particularly central role for the General Staff and its National Defence Management Centre

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20 Caitlin Talmadge, *The Dictator's Army: Battlefield Effectiveness in Authoritarian Regimes*, Cornell Studies in Security Affairs (Cornell University Press, 2015), https://www.jstor.org/stable/10.7591/j.ctt20d89pv.

21 Mark Galeotti, Pavel Baev, and Graeme P. Herd, 'Militaries, Mercenaries, Militias, Morale, and the Ukraine War', George C. Marshall European Center For Security Studies, 15 2022, https://www.marshallcenter.org/en/publications/clock-tower-security-series/strategic-competition-seminar-series-fy23/militaries-mercenaries-militias-morale-and-ukraine-war.

(NTsUO).[22] This awkward mixture of combined theatre commander, General Staff wartime roles, and the presence of informal command networks and irregular forces led the first phase of the war to be uncoordinated and poorly led.

Conversely, Ukraine benefited from a much more consolidated command structure as the war commenced, with clearer divisions of responsibility facilitated by the rapid introduction of martial law in the early hours of 22 February. This has been attributed primarily to a high level of decentralised yet quickly communicated action. Ukraine also benefited from a significant mobilisation of civilian personnel, structures, and networks to facilitate decentralised command structures across multiple fronts.

This does not mean Ukraine was free from issues in the higher command structures. Reportedly, a dispute between the head of the Ukrainian presidential office Andriy Yermak and then Chief of Defence General Valerii Zaluzhnyi nearly left Kyiv and the northern flank under-resourced as the war commenced. In one telling, Yermak began the process of redeploying the 72nd Mechanised Brigade to the eastern flank, believing the impending Russian assault would not try to take the capital. Zaluzhnyi, delaying these orders, kept the brigade in place. By doing so, the 72nd was able to counter the Russian assault on Hostomel airfield and contribute to the blunting of Russia's northern attack, which ultimately failed.[23] This seemingly sowed the seeds of discord which created further division and an increasingly dysfunctional relationship between the president's office and the Chief of Defence in the years thereafter.[24]

2.2.2. **Communications**

Communications nearly came to be a battlefield equaliser as the war began.

Communications nearly came to be a battlefield equaliser as the war began. On the Ukrainian side, a highly effective Russian cyber-attack crippled the VIASAT satellite network on which their defence communications relied.[25] For the Russians, underequipped troops came to rely on both civilian radios and mobile phone networks to maintain contact with higher command echelons.[26]

Ukraine, however, was able to offset its VIASAT loss by the rapid and mass deployment of SpaceX-owned StarLink satellite terminals in an acquisition facilitated by the US Agency for International Development (USAID).[27] Reportedly, StarLink came not only to support vital communications but also served as a backbone system used to support wider C4ISR functions like targeting. While rapidly reconstituted and highly effective in this early phase, the Ukrainian and USAID reliance on privately provided satellites would pose a challenge in later phases.

22 Alexis A. Blanc et al., 'The Russian General Staff: Understanding the Military's Decisionmaking Role in a "Besieged Fortress"' (RAND Corporation, 22 March 2023), https://www.rand.org/pubs/research_reports/RRA1233-7.html.

23 Alya Shandra, 'Syrskyi in, Zaluzhnyi out: What Our Army Sources Expect from the Ukraine's Army Reshuffle', Euromaidan Press, 10 February 2024, https://euromaidanpress.com/2024/02/10/syrskyi-in-zaluzhnyi-out-what-to-expect-from-ukraines-army-reshuffle/.

24 According to one account, the relationship between President Zelensky himself and his Chief of Defence were good during these first period the war with a clear division of responsibility and roles between the civil and military branches, before it deteriorated. See Simon Shuster, *The Showman: Inside the Invasion That Shook the World and Made a Leader of Volodymyr Zelensky*, First edition (New York, NY: William Morrow, 2024).

25 Patrick Howell O'Neill, 'Russia Hacked an American Satellite Company One Hour before the Ukraine Invasion', MIT Technology Review, 10 May 2022, https://www.technologyreview.com/2022/05/10/1051973/russia-hack-viasat-satellite-ukraine-invasion/.

26 Sam Cranny-Evans and Thomas Withington, 'Russian Comms in Ukraine: A World of Hertz', Royal United Services Institute, 9 March 2022, https://rusi.orghttps://rusi.org.

27 'USAID Safeguards Internet Access in Ukraine through Public-Private-Partnership with SpaceX', U.S. Agency for International Development, 5 April 2022, https://www.usaid.gov/news-information/press-releases/apr-05-2022-usaid-safeguards-internet-access-ukraine-through-public-private-partnership-spacex.

Beyond this initial cyber campaign, Russian electronic warfare efforts quickly began to take effect. The early morning of the invasion was preceded by the widespread application of electronic attacks to disrupt and damage Ukrainian defensive radar and air-defence installations, along with the extensive use of aerial decoys to saturate defences.[28] However, many of the initial Russian strikes were not using updated information. As a result, many sites were struck that had not been military positions for years and these attacks were less than effective. Many Ukrainian air defence systems survived but were uncoordinated for the first 24 hours, facilitating Russian airborne assaults in the north. As efforts came to concentrate on the Donbas, Russia set up Electromagnetic Warfare (EW) complexes that effectively disrupted navigation along the eastern front and aided artillery strikes on land as well as electronic attack against Ukrainian aircraft and UAVs.[29]

2.2.3. **Intelligence**

As the war began, both sides sought to leverage their prior intelligence to the greatest extent possible. Ukrainian indicators and warnings, supported by significant disclosures from their US and United Kingdom (UK) partners, provided ample warning time to coordinate rapid re-deployment and begin to coordinate civilian evacuations, even if the political leadership under Zelensky did not believe a full-scale invasion was imminent until the moment of the invasion itself.[30]

The Ukrainian armed forces benefited from significant experience in intelligence collection on Russian military dispositions and capabilities, as well as from external support. Vital to this effort was coordinated intelligence fusion between different agencies and partners to collaborate open-source intelligence (OSINT), human intelligence (HUMINT), and signals intelligence (SIGINT) into a coherent operating picture. This fusion was what effectively gave Ukrainian authorities an edge in last-minute redeployments and mobilisations to take advantage of the most up-to-date information, such as in the case of reinforcing the northern flank near Hostomel airfield. HUMINT, and its rapid disclosure by authorities in Washington and London, was particularly vital at this early stage to build an international coalition in support of Ukraine. By rapidly disclosing the findings from seemingly highly-placed HUMINT sources in Moscow, in what came to be referred to as "intelligence diplomacy", Ukraine's international backers were able to make an unequivocal case that this was in fact a full-scale invasion with the aim of decapitating the government in Kyiv.[31]

At the operational and tactical levels, the Ukrainian army quickly leveraged a wide range of Unmanned Aerial Vehicles (UAVs) to identify targets for indirect artillery and airstrikes, support manoeuvres at the small-unit level by providing real-time overhead imagery and delivering ordnance onto targets from the UAV itself using smaller, mortar-round sized shells. That this imagery was also quickly collected and disseminated by Ukrainian military and intelligence staff online gave the impression that the ubiquitous use of drones at all levels would be decisive in the coming war.

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28 Mykhaylo Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022' (Royal United Services Institute (RUSI), 30 November 2022), 24, https://static.rusi.org/359-SR-Ukraine-Preliminary-Lessons-Feb-July-2022-web-final.pdf.

29 Zabrodskyi et al., 37.

30 Shuster, *The Showman*.

31 John J. Sullivan, *Midnight in Moscow: A Memoir from the Front Lines of Russia's War against the West*, First edition (Boston: Little, Brown and Company, 2024); See also, Erin Banco et al., '"Something Was Badly Wrong": When Washington Realized Russia Was Actually Invading Ukraine', POLITICO, 24 February 2023, https://www.politico.com/news/magazine/2023/02/24/russia-ukraine-war-oral-history-00083757.

Additionally, Ukrainian special operations forces (SOF) and intelligence officers worked with partisan units behind Russian lines across the various flanks to further support targeting and general intelligence collection. Reportedly, this was especially effective in Crimea, where localised resistance groups loosely organised since the peninsula's annexation in 2014 began providing significant amounts of actionable intelligence to support Ukrainian missile and drone strikes on the Russian Black Sea fleet based at Sevastopol.[32]

For the Russians, their muddled intelligence collection in the pre-war phase caused near-immediate problems, especially as the northern assault against Kyiv bogged down. The Russian armed forces aimed to deliver a knock-out blow against pre-selected, but outdated, target lists across Ukraine. Despite a rapid insertion of airborne assault troops and combined arms attacks coming from Belarus and the Russian Western and Southern Military Districts, poor coordination and successful Ukrainian counterattacks slowed the initial assault. Perhaps the greatest example of this is the now (in)famous 'Russian Kyiv convoy' of roughly 15,000 troops spread over 64 kilometres on its way to Kyiv that was unable to link with forward units and consolidate the front on the right side of the Dnipro river. At the higher operational level, this slowed assault prevented the northern thrust and the Chernihiv front from combining and surrounding Kyiv, ultimately leading to the Russian abandonment of the northern campaign by April 2022.

This early phase highlights well the overall workings of the C4ISR complexes of both sides and how crucial close coordination and fusion are between the various elements of command complexes, ISR systems, and communications networks. Crucially, the system as a whole relies on each of these components functioning well enough in tandem, while being able to recover from early setbacks. The initial shock of the combat between February and April 2022 led both sides to adapt their aims and postures relatively quickly. This led to the situation largely settling over the summer into rough patterns that would persist throughout the later periods.

2.3. **Consolidated defence** (August – February 2023)

2.3.1. **Command**

The Russian commander Dvornikov and his successors Generals Gennady Zhidko and Sergey Surovikin are interesting in that their careers are noteworthy for meritocratic progression. In fact, Surovikin is arguably politically compromised as a participant in the botched August 1991 coup attempt while serving as the commander of a motor rifle battalion in Moscow, yet that didn't stop his rise through the ranks. Each were involved in Chechnya and Syria, where all were noted for their brutality, and each were awarded the Hero of the Russian Federation for their role in Syria. Ultimately, none of these three would remain in command for long, as Chief of the Russian General Staff Valery Gerasimov himself assumed direct command of the invasion in January 2023 after the successful Ukrainian Kharkiv counteroffensive in September/October 2022 and Russian morale at a low point. Promotion, then, had a

[32] Jessica Parker, 'Ukraine War: Atesh, the Group Spying on Russians in Occupied Crimea', *BBC*, 6 January 2024, https://www.bbc.com/news/world-europe-67659275.

pattern of meritocracy but was ultimately superseded by another pervasive feature of authoritarian armed forces: heavy centralisation.[33]

This heavily centralised command role for the Chief of Defence has become associated with the continued Russian strategy of grinding, attritional campaigns to take urban centres along the eastern front, such as in the battle for Bakhmut. According to Michael Kofman, Gerasimov was "exhausting the force with an ill-timed, feckless set of offensive operations, whose gains will not change the strategic picture for Russia, but could leave Russian forces more vulnerable."[34] These eastern offensives in the winter of 2022-2023 featured the heavy use of Wagner Group mercenaries who began taking significant losses.

For Ukraine, little changed in the way of command structures or arrangements. The Ground Forces' flexibility in its arrangements and a reportedly honed command habit of trusting subordinates to interpret commanders' intent, even if this habit may not have pervaded throughout all army units, was arguably a vital factor in the September-October 2022 Kharkiv counteroffensive which achieved significant gains on the eastern front.[35]

Through a weeks-long deception campaign and by leveraging interior lines of manoeuvre, the Ground Forces were able to spearhead a rapid offensive that took roughly 6,000 km^2 within 11 days. This allowed several brigades to conduct 'thunder run' attacks, where forward units raced along highways to key points and held them, and overwhelmed underdefended and poorly fortified Russian positions.[36] These types of rapid assaults require a degree of lower-level tactical initiative that is often difficult to achieve, as it is based on significant trust in ground commanders to execute commanders' intent accurately.[37] Through years of command adaptation, and with the experience of the initial months of the war, the Ukrainian ground forces were able to achieve these breakthroughs in autumn 2022 precisely because of this lower-level initiative.

2.3.2. **Communications**

For both sides, the communications picture remained complex in this period, given the heavy use of electronic warfare and the patchwork approaches of both Ukrainian and Russian forces. Russian forces continued to be vulnerable in their communications primarily due to the use of unencrypted devices both in battlefield use and to communicate with family at home. Ukrainian forces were able to monitor a significant quantity of these Russian tactical communications, and use them both for tactical and propaganda purposes, for example by leaking conversations between Russian soldiers and their families that revealed their locations or discussed war crimes.[38]

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33 Mike Eckel, 'Surovikin's Down, Gerasimov's Up: Russia's War On Ukraine Pivots Into Politics', *Radio Free Europe/Radio Liberty*, 12 January 2023, sec. Russia, https://www.rferl.org/a/russia-gerasimov-ukraine-commander-politics-war-surovikin/32220840.html.

34 'Russia Takes Stock After Winter Offensive Fails to Deliver Gains', The Moscow Times, 8 April 2023, https://www.themoscowtimes.com/2023/04/08/russia-takes-stock-after-winter-offensive-fails-to-deliver-gains-a80762.

35 Ryan, *The War for Ukraine: Strategy and Adaptation Under Fire*, 187–89.

36 Steve Maguire, 'Yes, Manoeuvre Is Alive. Ukraine Proves It.', Wavell Room, 4 November 2022, https://wavellroom.com/2022/11/04/yes-manoeuvre-is-alive-ukraine-proves-it/.

37 Stephen Biddle, 'Ukraine and the Future of Offensive Maneuver', War on the Rocks, 22 November 2022, https://warontherocks.com/2022/11/ukraine-and-the-future-of-offensive-maneuver/.

38 Jake Epstein, 'Russian Soldiers Are Relying Heavily on Their Personal Cellphones to Wage War in Ukraine Even Though It Risks Getting Them Killed', Business Insider, 27 July 2024, https://www.businessinsider.com/russian-soldiers-rely-phones-to-fight-ukraine-risks-killing-them-2024-7.

The use of Elon Musk's SpaceX StarLink assets became a topic of particular controversy in this period. As discussed above, StarLink had taken on an important backbone communications role for the Ukrainian armed forces, though in late 2022 increasingly became used for targeting as well. Communications between controllers and drones during the September-October 2022 raids against the Russian Black Sea Fleet at Sevastopol in Crimea became the tipping point in issues surrounding StarLink. Unbeknownst to the Ukrainian forces, Musk had insisted earlier that StarLink's effectiveness be 'geofenced' within 100 kilometres of the Crimean coast, supposedly out of concern that Ukrainian strikes on Crimea risked nuclear escalation.[39] Reportedly, as of March 2024, StarLink terminals are still being used to connect drone assets, including the types used in the Sevastopol raids, though any geofencing restrictions or limitations on target use are not publicly available.[40]

2.3.3. **Intelligence**

Enemy force disposition is by far the most vital piece of battlefield intelligence.

Russian intelligence during this period, specifically ISR assets, functioned comparatively better in conducting frequent missile and drone campaigns against Ukrainian critical infrastructure through the autumn of 2022 and over the winter of 2023. This targeting was lessened by the heavy use of Ukrainian air defence systems, which became gradually depleted over time given the scale and geographical breadth of the Russian strikes.[41] While the targets themselves were often quite uncomplicated, being fixed pieces of civilian infrastructure, the impact that was felt in Ukraine meant the strikes were hitting home during a freezing winter.

In other areas, however, Russian intelligence clearly failed again. The successful Ukrainian deception operation to enable the Kharkiv offensive and the ability of Ukrainian forces to conduct regular disruptive raids in and around Crimea indicates a lack of warning information within the Russian military intelligence community, though it could also be command failures to act on available intelligence. Enemy force disposition is by far the most vital piece of battlefield intelligence, and on two major fronts, Russian intelligence was insufficient to identify and track large Ukrainian troop movements.

Ukrainian troops were clearly able to overcome StarLink limitations and work with a patchwork of sensors, including security-breached cameras near sensitive sites in Crimea, and local partisans within occupied territories to identify weak points. In both the Kharkiv offensive and the Sevastopol raids, targets found their marks and in each domain achieved decisive effect, with the ground forces retaking swathes of territory and the Russian Black Sea Fleet being forced to operate from the more secure Novorossiysk Naval Base east of Crimea.

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39 Walter Isaacson, '"How Am I in This War?": The Untold Story of Elon Musk's Support for Ukraine', *The Washington Post*, 7 September 2023, https://www.washingtonpost.com/opinions/2023/09/07/elon-musk-starlink-ukraine-russia-invasion/.

40 Maria Drutska [@maria_drutska], 'The Security Service of Ukraine Showcased the Testing of the First Sea Baby Drone, Made Possible by Donations from Ukrainians.', Tweet, *X (Formerly Twitter)*, 6 March 2024, https://x.com/maria_drutska/status/1765375019922710533.

41 Riley Bailey and Frederick W. Kagan, 'Special Report: Russian Strikes More Effective as Ukraine Exhausts Defenses' (Institute for the Study of War (ISW), 12 April 2024), http://dev-isw.bivings.com/.

2.4. **Counterattack** (March – September 2023)

2.4.1. **Command**

Russian command structures faced one of their most serious challenges of the war during the spring-summer Ukrainian counteroffensives. While these offensives were less successful than hoped for by Kyiv, the casualty rate for Russian forces in stopping the counterattacks on multiple fronts was huge. The strain on irregular forces such as the Wagner Group was particularly high. The Russian higher command, under the notional leadership of Gerasimov, remained fragmented and unable to contain collapsing troop morale and at some point active rebellion, when Prigozhin marched on Moscow before aborting it, in an attempt to prevent the integration of the Wagner group into the regular armed forces.[42]

After the counteroffensives stalled, due largely to the success of Russian fortified defensive lines and complexes, Moscow began to adapt its command structures. This began with relieving the commander of the 58th Combined Arms Army Ivan Popov for criticising Russian strategy in the south.[43] By September, Moscow had reformed its command structure to be less hierarchical, moved their command posts further behind the front line to reduce the risk of decapitation, and worked to rationalise the command and control of irregular units within regular army structures.[44] The most dramatic of this was the restructuring of Wagner Group after the (suspicious) death of its leader Yevgeniy Prigozhin, wherein its fighters were made to swear an oath to the Russian state.[45]

In the Ukrainian Armed Forces, tensions rose within the higher command as the much-anticipated summer counteroffensive stalled against Russian defences. General Zaluzhnyi and his staff complained about political interference in operational decisions and accused the president and his advisers of favouring certain generals and cutting Zaluzhnyi out of key decision-making procedures. Meanwhile, Zelensky and the presidential office claimed that it was Zaluzhnyi's own plans that led to unrealistic expectations for the counteroffensive.[46] The stalled counteroffensive, which had reportedly been predicted by US intelligence to likely make only moderate territorial gains, would become a major sticking point in Ukrainian civil-military relations later in the year.[47]

Developing effective command staff, especially ground force G3 (operations) planners, has been a particular problem for Ukraine. According to the Royal United Services Institute

42 Riley Bailey et al., 'Russian Offensive Campaign Assessment, June 9, 2023' (Institute for the Study of War (ISW), 9 June 2023), http://dev-isw.bivings.com/.

43 'Russian General in Ukraine Removed for Strategy Criticism: Report', Al Jazeera, 13 July 2023, https://www.aljazeera.com/news/2023/7/13/russia-general-in-ukraine-removed-over-strategy-criticism-report.

44 Margarita Konaev and Owen J. Daniels, 'The Russians Are Getting Better: What Moscow Has Learned in Ukraine', Foreign Affairs, 6 September 2023, https://www.foreignaffairs.com/ukraine/russians-are-getting-better-learning.

45 Andrew Osborn, 'Putin Orders Wagner Fighters to Sign Oath of Allegiance', *Reuters*, 26 August 2023, sec. Europe, https://www.reuters.com/world/europe/kremlin-calls-accusations-it-killed-wagner-boss-prigozhin-an-absolute-lie-2023-08-25/.

46 Eric Ciaramella, 'Why Zelensky Replaced Ukraine's Top General and What It Means for the War', Lawfare, 22 February 2024, https://www.lawfaremedia.org/article/why-zelensky-replaced-ukraine-s-top-general-and-what-it-means-for-the-war.

47 John Hudson and Missy Ryan, 'U.S. Officials Were "Furious" about Leaks Exposing Ukraine War Concerns', *The Washington Post*, 13 December 2023, https://www.washingtonpost.com/national-security/2023/12/13/ukraine-war-discord-leaks/.

(RUSI)'s Jack Watling and Nick Reynolds, while conscription and volunteers had swelled the lower ranks, 'planning shops and experienced G3 staff are scarce...This limits the scale at which brigades can combine arms, especially during offensive operations where planning times are compressed.'[48] This, coupled with NATO-provided staff training that Ukrainian officers complained ignored their more recent operational experience and sought to put them into a NATO model of brigade-level warfighting, led to a dearth of operational planning staff needed to coordinate the theatre-wide offensive.[49]

2.4.2. **Communications**

Russian communications systems, especially those necessary to improve fire direction and control drones at the small-unit level, improved in this period. The Russian military concept of a 'reconnaissance fires complex' had yet to be fully orchestrated thus far in the war. Shortfalls in military radio equipment that had initially been filled with unsecured civilian assets were now gapped using app-based services for encoding and accessing data.[50] The particular system, Strelets, is an individually-carried fire and control system that incorporates basic radio and satellite communications capabilities and includes a differentiated type distributed to commanders.[51] While there was and still is doubt about the network security and reliability of this system, the fact that small units of the Russian ground forces were no longer relying on outdated radios or civilian networks marks an important shift. However, in the air, Russia took an important loss in June 2023 when Ukrainian air defence downed an Il-22 airborne command post, a vital asset for airborne C2.[52]

Ukraine reportedly struggled with its communications during the counteroffensive, though the precise issues experienced are less clear than in earlier stages.[53] Seemingly, the challenges were related to Russia's jamming and electronic warfare capabilities disrupting fire and control for assets such as HIMARS.[54] This is likely due to the wider dispersal of electronic warfare equipment across the Russian ground and aerospace forces, rather than the previous centralised control over larger EW assets. Furthermore, if Russian EW was active in an area, Ukrainian forces were simply unable to fully leverage UAVs to support their movements.[55]

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48 Jack Watling and Nick Reynolds, 'Stormbreak: Fighting Through Russian Defences in Ukraine's 2023 Offensive' (The Royal United Services Institute (RUSI), 4 September 2023), https://rusi.orghttps://rusi.org.

49 Jamie Dettmer, 'Ukraine's Forces Say NATO Trained Them for Wrong Fight', POLITICO, 22 September 2023, https://www.politico.eu/article/ukraine-war-army-nato-trained-them-wrong-fight/.

50 Watling and Reynolds, 'Stormbreak'.

51 'Strelets (Index 83t215i): Reconnaissance, Control and Communications Complex', ROSOBORONEXPORT - Russian Defence Export, accessed 16 December 2024, https://roe.ru/eng/catalog/land-forces/military-communications-equipment-and-automated-control-systems/automated-control-systems/strelets/.

52 'Attack On Europe: Documenting Russian Equipment Losses During The Russian Invasion Of Ukraine', Oryx, 24 February 2022, https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html.

53 Hlib Parfonov, 'Russia's War Against Ukraine: Lessons Learned in 2023 and 2024 Outlook' (The Jamestown Foundation, 28 January 2024), https://jamestown.org/program/russias-war-against-ukraine-lessons-learned-in-2023-and-2024-outlook/.

54 Alex Marquardt, Natasha Bertrand, and Zachary Cohen, 'Russia's Jamming of US-Provided Rocket Systems Complicates Ukraine's War Effort', CNN, 6 May 2023, https://www.cnn.com/2023/05/05/politics/russia-jamming-himars-rockets-ukraine/index.html.

55 Thomas Gibbons-Neff and Yurii Shyvala, '"Jamming": How Electronic Warfare Is Reshaping Ukraine's Battlefields', *The New York Times*, 12 March 2024, sec. World, https://www.nytimes.com/2024/03/12/world/europe/ukraine-drone-russia-jamming.html.

2.4.3. **Intelligence**

The Russian intelligence services had a period of mixed performance in this period. There were reports during this period of infighting between the FSB and the Ministry of Defence, with the FSB accusing the GRU of fabricating information about battlefield progress and casualty rates.[56] Off the battlefield, the FSB and SVR underwent reforms that revamped operations in Europe leading disinformation campaigns and dividing up Wagner Group operations amongst themselves, with a particular focus on increasing intelligence and SOF efforts in Africa.[57]

Ukrainian intelligence, working with special operations forces and volunteer units of Russian citizens backed by Ukrainian intelligence, successfully conducted deep behind-the-lines strikes in preparation for the counteroffensive. The ability of Ukrainian intelligence and SOF forces to conduct such raids and support active irregular units inside Russia speaks to their abilities in HUMINT cultivation and covert operations.[58] Asymmetric attacks inside Russia supported by Ukrainian intelligence/SOF continued throughout the offensive, targeting airfields, military infrastructure, the Kerch strait bridge, and central Moscow itself.[59] While there had been significant battlefield intelligence preparation and efforts behind the lines, this proved insufficient to open up breakthroughs by regular forces.

2.5. **Stalemate** (October 2023 – November 2024)

2.5.1. **Command**

The Ukrainian higher command environment worsened over the autumn of 2023 and into 2024 as the tensions between the presidential office and Zaluzhnyi escalated, exacerbated in part by the slowing of military support from the US and Europe. In November 2023, General Zaluzhnyi gave an interview to *The Economist*, in which he stated that the faltering Ukrainian counteroffensive was not going to achieve the gains it sought to, in contradiction to Zelenskyy's continually optimistic statements about the operation at the time.[60] Zaluzhnyi had since the early 2022 defence of Kyiv become politically popular, and his increasingly outspoken differences with the presidential office was gradually undermining his relationship with Zelenskyy. By January 2024, Zelenskyy chose to replace Zaluzhnyi with Colonel General Oleksandr Syrskyi, commander of the Kharkiv counteroffensive and of the defence of Bakhmut.[61] Zaluzhnyi would be appointed the Ukrainian ambassador to the UK in March 2024.

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56 Anton Troianovski et al., 'New Leaked Documents Show Broad Infighting Among Russian Officials', The New York Times, 13 April 2023, https://www.nytimes.com/2023/04/13/world/europe/russia-intelligence-leaks.html.

57 'Russian Spies Are Back—and More Dangerous than Ever', *The Economist*, 20 February 2024, https://www.economist.com/international/2024/02/20/russian-spies-are-back-and-more-dangerous-than-ever.

58 Andrew S. Bowen, 'Russia's War in Ukraine: Military and Intelligence Aspects' (Congressional Research Service, 14 September 2023), 22.

59 Bowen, 27.

60 'Ukraine's Commander-in-Chief on the Breakthrough He Needs to Beat Russia', *The Economist*, 1 November 2023, https://www.economist.com/europe/2023/11/01/ukraines-commander-in-chief-on-the-breakthrough-he-needs-to-beat-russia.

61 Tom Balmforth and Olena Harmash, 'Ukraine Replaces Army Chief in Shakeup at Difficult Time in War with Russia', Reuters, 9 February 2024, https://www.reuters.com/world/europe/ukraines-zelenskiy-says-time-has-come-changes-top-military-2024-02-08/.

For the Russian forces, the command structure adaptations taken in autumn 2023 continued to be put into place, and by early 2024 the battlefield benefits were apparent during the capture of Avdiivka in February. Contrary to the early phases of the war in which Russian forces struggled to conduct effective combined arms manoeuvres, the opening phases of the battle in October 2023 featured a rapid assault by armoured assault groups and helicopters with artillery support of the 8th Combined Arms Army. As the battle slowed down over the winter, Russian forces then used a series of tunnelling operations by reconnaissance units to undermine Ukrainian fortifications, and ultimately take the city.[62] This can perhaps be explained in part by the command abilities of the Russian commander of the Central Military District, General Andrey Mordvichev, who also had sufficient room to take initiative in the operation to take the city.

2.5.2. **Communications**

Russian communications continued to improve marginally over this period, with a particular focus on improving the coded communications system between command posts and military units though, as this has not been established at the battalion level or below, some soldiers seemingly still used unsecured civilian communications.[63] The incoming new minister of defence Andrey Belousov reportedly emphasised modernising Russian communications equipment as a major priority, and this could lead to the wider rollout of the Strelets system to smaller units to improve battlefield connectivity.

Ukraine's communications suffered a major cyberattack on 12 December 2023, this time targeting the Kyivstar mobile communications network, with more than 25 million subscribers temporarily losing access to services. Though Kyivstar is a civilian network, important civil defence messages such as air attack warnings are broadcast across its services. It is not likely that this attack was intended to degrade battlefield communications networks, which remained secure, but rather to coincide with winter bombing campaigns against other civilian infrastructure in order to inflict as much disruption as possible.

2.5.3. **Intelligence**

Ukrainian intelligence appears in this stage to be functioning as well as in the previous periods, with the challenge being not a lack of intelligence but rather a lack of sufficient supplies to take advantage of intelligence. In an interview with *The Economist*, the head of Ukrainian military intelligence Major General Vadym Skibitsky expressed an awareness of Russian capabilities and intentions that appears to mark both a continually functional intelligence apparatus as well as ongoing support from partner agencies. However, there may be challenges to tactical intelligence on some fronts. A possible example is the May 2024 Russian offensive in the Kharkiv region, which seemingly caught Ukrainian forces there by surprise.[64] It is far too early, as of the moment of writing, to generalise about the state of frontline intelligence elsewhere, however.

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62 Stefan Korshak, 'Russian Infantry Scores Gains in Battleground Avdiivka, Both Sides Predict More Big Attacks', Kyiv Post, 26 January 2024, https://www.kyivpost.com/post/27219.

63 Anna Maria Dyner, 'Russia's Armed Forces Two Years After the Full-Scale Invasion of Ukraine' (The Polish Institute of International Relations, 28 February 2024), https://pism.pl/publications/russias-armed-forces-two-years-after-the-full-scale-invasion-of-ukraine#_ftn15.

64 Victoria Butenko et al., 'Russia Mounts Surprise Assault on Northern Ukraine in Most Serious Cross-Border Offensive in Two Years', CNN, 11 May 2024, https://www.cnn.com/2024/05/10/europe/russia-ukraine-cross-border-kharkiv-intl/index.html.

The state of Russian military intelligence collection and activities is far more difficult in this period. There are certainly signs of increased capability due to both the Avdiivka and Kharkiv offensives. As Ukrainian air defence stocks have slowly been depleted, there has been an increase in Russian airborne ISR collection across the front lines, leading to an increase in deep strikes against the positions of critical weapons and sites by guided tactical missiles.[65]

65 Jack Watling, 'In Ukraine, Russia Is Beginning to Compound Advantages', Royal United Services Institute, 14 May 2024, https://rusi.orghttps://rusi.org.

3. Taking, Holding, and Losing Land

3.1. Introduction

The land domain is where a cross-cutting analysis between Ukraine and Taiwan becomes far more challenging simply because the geographic differences are considerable. Russia, Belarus, and Ukraine share over 3,000 kilometres of land border with few natural barriers, and Moscow already controlled territory in Ukraine's east as well as the Crimean Peninsula in the south. In the early hours of the full-scale Russian invasion, land forces were able to roll right over the border and along long highways towards their mission areas. Taiwan of course shares no land borders with the PRC, or any other state for that matter. The land battle in Taiwan is therefore determined by either side's ability to gain and maintain air and naval superiority to either facilitate an amphibious and airborne landing or to repulse it.

The question here is how land forces can achieve their conventional territorial defence mission while also contributing to a wider campaign. The central theme of the ongoing Russian invasion is how the Ukrainian armed forces survived an attack by what on paper was a superior Russian force with massive firepower and ISR assets, while purportedly to be fully modernised. In addition, Ukrainian forces managed to not only hold terrain but in the later phases of the war, retake land from the Russian invaders. As taking and holding land in the face of firepower, whether through dispersion, mobility and speed, hiding, or hardening, was the central challenge of 20thcentury warfare, the current war shows that this persists also in the 21st century.

3.2. Invasion and its repellence (December 2021 – July 2022)

During the first phase of Russia's war against Ukraine, both sides registered a series of successes and failures both in taking and holding land. Prior to the full-scale invasion of February 2022 and since 2014, Russia had already illegally seized about 42,000 square kilometres of Ukrainian territory – a territory the size of the Netherlands.[66] Even though the initial operations to seize Kyiv and decapitate the government failed, the Russian armed forces did manage to seize and control almost 119,000 square kilometres of Ukrainian territory, or one-fifth of Ukrainian territory, in the first week.[67] At one point, one month into the invasion, Russia controlled 27% of Ukrainian territory. Figure 2 shows the status of the invasion as of 31 March 2022.

66 'Cabinet of Ministers of Ukraine: Orders. On Approval of the List of Settlements on the Territory of Which State Authorities Temporarily Do Not Exercise Their Powers and the List of Settlements Located on the Demarcation Line' (Translated from Ukrainian), Parliament of Ukraine, 7 November 2014, https://zakon.rada.gov.ua/go/1085-2014-%D1%80.

67 'Ukraine Conflict Updates 2022', Institute for the Study of War, 2022, http://dev-isw.bivings.com/; 'The Turning Points in Russia's Invasion of Ukraine', accessed 26 February 2024, https://www.cnn.com/interactive/2022/09/europe/russia-territory-control-ukraine-shift-dg/.

Figure 2. Status of the Russian invasion in Ukraine as of 31 March 2022

Source: Institute for the Study of War

However, after Russia's failed attempt to establish air superiority and take control of Hostomel Airport close to Kyiv as a bridgehead to transport incoming forces and supplies, the invading forces got bogged down. The Russian High Command was forced to adjust its operational plans. By April 2022 Russian forces retreated from Kyiv and the northeast of Ukraine, including Chernihiv and Sumi, to focus their efforts on the Eastern and Southern fronts, thereby ceding 40% of the gains it made since the beginning of the invasion.[68]

Ukraine, for its part, was not able to fully prevent Russia's initial multifront advance but the Ukrainian armed forces successfully made use of Ukraine's strategic depth, exchanging territory for time and drawing in Russian forces to fight them in conditions more favourable to Ukrainian defenders, including in urban environments, forests, and rivers. Ukraine managed to inflict considerable costs on the invading forces and successfully repelled Russian efforts to capture Kyiv and other important cities in the northeast of the country. Most significantly, in May 2022, Ukraine regained territory in the Kharkiv Oblast, pushing Russian forces up to 40km east of Kharkiv. Despite Ukraine's strong defence, Ukraine also suffered strategic losses, including when the Russian army seized Mariupol and Lysychansk in July 2022, establishing a land link between occupied eastern Ukraine and Crimea.[69]

The first stage of the war highlighted once again the importance of fundamental tenets of force employment in the modern war system for an invading force trying to occupy land. Russia's

68 Seth G. Jones, 'Russia's Ill-Fated Invasion of Ukraine: Lessons in Modern Warfare', 6 January 2022, 2, https://www.csis.org/analysis/russias-ill-fated-invasion-ukraine-lessons-modern-warfare.

69 'Ukraine Conflict Updates 2022'; 'The Turning Points in Russia's Invasion of Ukraine'; Matthew Mpoke Bigg, 'How Russia's War in Ukraine Has Unfolded, Month by Month.', *The New York Times*, 24 February 2023, sec. World, https://www.nytimes.com/article/ukraine-russia-war-timeline.html.

Battalion Tactical Groups (BTGs, combined arms units drawn from companies and battalions in existing brigades)[70] in practice lacked the ability to conduct combined arms operations. Russian operations suffered from limited, slow, and corrupted communication channels between operational and tactical units, which included air support, long-range fires, as well as other BTGs, and fatal flaws in the execution of ground operations leading to massive losses of men and materiel.

The personnel composition of BTGs, further exacerbated by amalgamation after losses, undermined intra-unit trust and cohesion and contributed to confusion and low levels of learning and adaptation amongst Russian troops. Moreover, there was a demonstrable lack of basic unit training amongst frontline land troops, such as bunching up and failing to take cover during an ambush.[71] Russian advances were further hampered by poor logistics that led to clogging of roads and lines of communications, broken supply chains, including a failure to provide convoy security to logistics vehicles, reducing the impact of Russia's superior quantity in terms of man- and firepower.[72] In turn, Russia compensated for ineffective manoeuvre forces with an increasing reliance on the mass use of artillery and a general disregard for the loss of human life amongst both regular forces and auxiliaries.[73]

The first stage of the war highlighted once again the importance of fundamental tenets of force employment in the modern war system for an invading force trying to occupy land.

In contrast, Ukraine demonstrated considerable adaptability at the military-operational and tactical levels of war, anticipating Russian moves, adapting to changed circumstances, and continuously implementing capabilities and concepts of employment.[74] In the hours before the invasion, Ukrainian forces dispersed ammunition, air defence, and tactical units to prevent their destruction from the initial salvoes of Russian missile and air attacks. This certainly increased their survivability at the moment of Russia's invasion.[75] At the same time, this meant that many units were not in place at their assigned defensive positions at the time of Russia's initiation of the invasion.[76]

Ukraine relied on the independent movement of small units, which carried out hit-and-run attacks against Russian columns while reducing the chances of detection. Ukrainian commanders paired special forces armed with man-portable anti-tank weapons with local reserves riding four-wheeled off-road vehicles. This combination allowed troops to "hit Russian logistics elements deep behind the initial assault forces" at the outset of the war.[77] Ukrainian forces also effectively used urban settlements (basements, cellars, subterranean infrastructure) to increase their survivability.[78] Dispersion, small-unit independent movement,

70 Márk György Takács, 'A Short Study: Describing the Major Features of the Russian Battalion Tactical Group Based on Their Performance on the Battlefield', *Hadtudomány* 33, no. 3 (22 December 2023): 47–63, https://doi.org/10.17047/HADTUD.2023.33.3.47.

71 Mykhaylo Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022' (RUSI, 2022), https://www.rusi.org/explore-our-research/publications/special-resources/preliminary-lessons-conventional-warfighting-russias-invasion-ukraine-february-july-2022. Jones, 'Russia's Ill-Fated Invasion of Ukraine'; T. X. Hammes, 'Game-Changers: Implications of the Russo-Ukraine War for the Future of Ground Warfare', *Atlantic Council* (blog), 3 April 2023, https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/game-changers-implications-of-the-russo-ukraine-war-for-the-future-of-ground-warfare/.

72 Bradley Martin, D. Sean Barnett, and Devin McCarthy, 'Russian Logistics and Sustainment Failures in the Ukraine Conflict: Status as of January 1, 2023' (RAND Corporation, 11 July 2023), https://www.rand.org/pubs/research_reports/RRA2033-1.html.

73 Jones, 'Russia's Ill-Fated Invasion of Ukraine'; Hammes, 'Game-Changers'.

74 Viktoriya Fedorchak, *The Russia-Ukraine War: Towards Resilient Fighting Power* (London: Routledge, 2024), 169–70, https://doi.org/10.4324/9781003351641.

75 Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022'.

76 Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022', 23.

77 Hammes, 'Game-Changers'.

78 Louis DiMarco, 'Urban Operations in Ukraine: Size, Ratios, and the Principles of War', Modern War Institute, 20 June 2022, https://mwi.westpoint.edu/urban-operations-in-ukraine-size-ratios-and-the-principles-of-war/.

concealment, and cover were thus used by the Ukraine forces to operate under conditions of heightened battlefield transparency from Russian ISR.[79] The use of legacy systems, such as T-64 tanks and BM-21 Grad MLRS were also key to Ukraine's survival by quickly fielding mass on land.[80] Stockpiling and preparedness for war helped Ukraine achieve some major successes, such as repelling the attack on Kyiv. However, already in this initial phase, Ukraine faced shortages of ammunition, spare parts, and other equipment.

Especially during the initial stages of the war, unmanned aerial systems were important C4ISR assets at different levels. These conferred significant tactical advantages when used properly. Both Ukraine and Russia have used drones to detect threats and reconnoitre on the frontline of the battlefield, ranging from small unit-level systems to larger ISR drones controlled at brigade-level echelons and above.[81] In addition, the use of drones helped Ukrainian troops "to repel and deter Russian aircraft from making near-border and cross-border strikes."[82] Ukrainian successes were further facilitated by the underwhelming performance of Russia's air defence and electronic warfare capabilities, following Russia's failure to establish air superiority.[83]

Russia also made deliberate efforts to target and control Ukraine's nuclear infrastructure, underscoring Moscow's strategy of leveraging critical civilian assets to coerce and destabilise the country.[84] By seizing the Zaporizhzhia Nuclear Power Plant and launching assaults near other facilities, Russia weaponised Ukraine's dependence on nuclear energy, which before the war accounted for over 50% of Ukraine's electricity supply.[85] However, while Russia succeeded in seizing nuclear power plants and impair other energy production facilities, it faced significant operational and tactical limitations in irreparably damaging the energy infrastructure of Ukraine. The Russian military's lack of precision in strikes and limited munitions, coupled with early operational disorganisation and the robust performance of Ukrainian air defences, mitigated the broader impact of these efforts.[86]

Finally, as in all wars, the terrain itself contributed to failures and successes on both sides. Russia's invasion during the winter took off at a moment when cold weather provided hard, fast terrain facilitating the movement of heavy armoured vehicles. However, as Russian forces advanced slower than forecasted, many got bogged down in spring when the terrain started to thaw, slowing down offensive operations.[87] Ukraine's forests and marshes meant Russian

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79 Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton University Press, 2004), https://doi.org/10.2307/j.ctt7s19h.

80 Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022', 65.

81 Franz-Stefan Gady, 'How an Army of Drones Changed the Battlefield in Ukraine', *Foreign Policy* (blog), 28 February 2024, https://foreignpolicy.com/2023/12/06/ukraine-russia-war-drones-stalemate-frontline-counteroffensive-strategy/.

82 Kristen Thompson, 'How the Drone War in Ukraine Is Transforming Conflict', Council on Foreign Relations, 16 January 2024, https://www.cfr.org/article/how-drone-war-ukraine-transforming-conflict.

83 Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022'; Thompson, 'How the Drone War in Ukraine Is Transforming Conflict'.

84 Darya Dolzikova and Jacks Watling, 'Dangerous Targets: Civilian Nuclear Infrastructure and the War in Ukraine' (RUSI, 10 December 2024), https://rusi.orghttps://rusi.org.

85 Tim Gould, 'Ukraine's Energy System under Attack – Ukraine's Energy Security and the Coming Winter – Analysis' (IEA), accessed 11 December 2024, https://www.iea.org/reports/ukraines-energy-security-and-the-coming-winter/ukraines-energy-system-under-attack; Talya Vatman and Craig Hartman, 'Russia's Attacks on Ukraine's Energy Sector Have Escalated Again as Winter Sets in – Analysis', IEA, 17 January 2024, https://www.iea.org/commentaries/russias-attacks-on-ukraines-energy-sector-have-escalated-again-as-winter-sets-in.

86 Vatman and Hartman, 'Russia's Attacks on Ukraine's Energy Sector Have Escalated Again as Winter Sets in – Analysis'.

87 Angeline Heckel-Elies, 'What the Onset of "General Winter" Means for Vehicle Operational Capabilities in Ukraine', Soucy Defense Division, 25 January 2023, https://soucy-defense.com/winter-vehicle-operational-capabilities-ukraine/.

troops needed to use roads to advance. Road congestion and the forest environment allowed Ukrainian troops to carry out ambushes along the lengths of major highways across each axis of advance. Additionally, forests favoured concealment.[88] The geography of the wider Kyiv area contributed to Ukraine's ability to prevent a pitched battle over the capital, with both the Dnieper River and its tributaries, such as the Irpin river, traversing the area. These rivers were natural obstacles for Russian forces that experienced constraints on their manoeuvrability due to peat bogs and marshes, and on several occasions failed to cross the rivers, or only after suffering significant losses.[89] Additionally, Kyiv has an extensive underground metro system. Over 60 km of tunnels provided shelter to civilians and military forces increasing their survivability.[90]

The course of the first phase of the war came as a surprise to many observers. Pre-war assessments had envisioned a relatively short, decisive conflict in which Russia either fully seized the eastern oblasts or even took Kyiv itself.[91] Some of the more optimistic takes imagined a three-week war, while others estimated a Ukrainian surrender within 72 hours. A combination of overestimating Russia and underestimating Ukraine lay behind these assessments, as discussed in the introduction. Ukraine's mixture of mobility, flexibility, and localised ground superiority, coupled with the integration of drone technologies and knowledge of the terrain, alongside Russia's poorly trained troops, bad intelligence, and logistical failures came together to deny Russia the *fait accompli* it had hoped to achieve.

3.3. **Consolidated defence** (August 2022 – February 2023)

During the second phase of the war, both sides achieved only marginal territorial gains. In this phase, the conflict turned into a war of attrition featuring "dug-in forces, trenches, human-wave attacks, artillery barrages, and high casualties on both sides."[92] Russia failed to consolidate its hold in the Kharkiv Oblast, the site of Ukraine's first major counteroffensive. Ukrainian forces successfully targeted ground lines of communications, munitions deposits, and road bridges to make them inoperable for Russia's heavy equipment.[93] Ukrainian special forces even managed to stage an attack on a Russian air base and various ammunition depots in Crimea, striking deep beyond the front lines.[94] Ukraine also began deploying US-provided HIMARS to damage Russia's ammunition supply lines, causing shortages and disruptions.[95] Figure 3 illustrates the status of the invasion as of 31 August 2022.

88 Jones, 'Russia's Ill-Fated Invasion of Ukraine', 6.

89 'Ukraine War: Kyiv Terrain Will Slow Russian Troops, Say Ukraine Generals', *BBC News*, 15 March 2022, sec. Europe, https://www.bbc.com/news/world-europe-60745493.

90 'Military Briefing: How the Battle for Ukraine Became a Battle for Its Cities', Financial Times, March 2022, https://www.ft.com/content/0f2ddbeb-9681-4130-97b2-bfb74f8e58e8?segmentId=2c1df321-36a4-1206-2c08-112c059dd69d.

91 Cohen, O'Brien, and Strachan, 'The Russia-Ukraine War'.

92 Seth G. Jones, Riley McCabe, and Alexander Palmer, 'Ukrainian Innovation in a War of Attrition', 27 February 2023, 2, https://www.csis.org/analysis/ukrainian-innovation-war-attrition.

93 'Ukraine Conflict Updates 2022'; John Psaropoulos, 'Timeline: Six Months of Russia's War in Ukraine', Al Jazeera, 24 August 2022, https://www.aljazeera.com/news/2022/8/24/timeline-six-months-of-russias-war-in-ukraine.

94 Sammy Westfall, 'A Russia-Ukraine Timeline: Key Moments, from Attack on Kyiv to Counteroffensive', Washington Post, 9 June 2023, https://www.washingtonpost.com/world/2023/06/09/russia-ukraine-war-timeline-counteroffensive/.

95 Jones, McCabe, and Palmer, 'Ukrainian Innovation in a War of Attrition', 9.

Figure 3. Status of the Russian invasion in Ukraine as of 31 August 2022

Source: Institute for the Study of War

At the end of September 2022, Russia still controlled 116,000 square kilometres of Ukrainian territory (including Crimea), or roughly 19% of the country. By December 2022, Russia maintained control of 16.6% of Ukrainian territory.[96]

In this second phase of the war, Ukraine continued to become better at integrating drones in more sophisticated strike complexes, employing cheap and voluminous drones at different echelons. This enabled the Ukrainian forces to increase their overall battlefield awareness and to find and fix targets.[97] Yet, during this phase of the war, Russian ground forces became better at neutralising these same drones, with intercept rates increasing.

The Ukrainian forces also made deft use of drones, commercial satellites and targeting software to enhance battlefield transparency and shorten sensor-to-shooter cycles, for instance through the use of Kropyva, an intelligence mapping and artillery software which is fed information using imagery by forward-deployed tactical units. The use of commercial satellites increased considerably as commercial firms increasingly provided data to the Ukrainian forces, with over 40 companies doing so by December 2022.[98]

The Russian army, in turn, started to reorganise its primary ground combat units, from BTGs to stratified divisions into line, assault, specialised and disposable troops.[99] While the stratification allowed units to operate in a dispersed manner, they possessed much less firepower.[100]

96 'War in Ukraine: Russia Now Controls Only 16% of Ukrainian Territory', *Le* Monde.Fr, 6 January 2023, https://www.lemonde.fr/en/les-decodeurs/article/2023/01/06/war-in-ukraine-russia-now-controls-only-16-of-ukrainian-territory_6010578_8.html.

97 Federico Borsari and Davis Gordon B. 'Skip', 'An Urgent Matter of Drones', Center for European Policy Analysis (CEPA), 27 September 2023, https://cepa.org/comprehensive-reports/an-urgent-matter-of-drones/.

98 Hammes, 'Game-Changers', 7.

99 Jack Watling and Nick Reynolds, 'Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine', 23 February 2024, https://rusi.orghttps://rusi.org.

100 Hammes, 'Game-Changers', 2.

Low morale continued to hinder intra-unit cohesion and inter-unit cooperation.[101] Russian artillery forces started to more structurally integrate drones enhancing their mobility, and reducing their vulnerability to counterbattery fire.[102] Following the loss of stockpiles as a consequence of Ukrainian attacks in the summer of 2022, Russian employment of artillery was shaped by ammunition availability as it waited for production to increase, that would not materialise in this phase of the war.[103]

3.4. **Counterattack** (March 2023 – September 2023)

The third phase of the war, focused on the preparation and execution of the Ukrainian counter-offensive brought limited territorial gains to Ukraine. As the Ukrainians failed to deliver a quick counteroffensive, it gave Russia time to prepare by creating a defence infrastructure based on landmines, ditches, trenches, hardened covers, and artillery positions.[104] On average, Ukraine advanced only 90 meters per day during the summer counteroffensive translating into a total 7.5 kilometres advance.[105] Figure 4 presents the status of the invasion in Ukraine as of 30 April 2023.

Figure 4. Status of the Russian invasion in Ukraine as of 30 April 2023

Source: Institute for the Study of War

101 Watling and Reynolds, 'Meatgrinder', 23 February 2024.

102 David Hambling, 'Russians Are Developing An Arsenal Of Deadlier FPV Drones — But Bureaucracy Is Holding Them Back', Forbes, 1 September 2023, https://www.forbes.com/sites/davidhambling/2023/09/01/russias-new-arsenal-of-deadlier-fpv-drones-is-coming--if-they-can-get-through-the-bureaucracy/.

103 Patrick Tucker, 'Russia Seems to Be Running Low on Drones', Defense One, 12 July 2022, https://www.defenseone.com/technology/2022/07/russia-seems-be-running-low-drones/374157/.

104 Mariano Zafra and Jon McClure, 'Mapping Ukraine's Counteroffensive', *Reuters*, 21 December 2023, https://www.reuters.com/graphics/UKRAINE-CRISIS/MAPS/klvygwawavg/.

105 Seth G. Jones, Riley McCabe, and Alexander Palmer, 'Seizing the Initiative in Ukraine: Waging War in a Defense Dominant World' (CSIS, October 2023), https://www.csis.org/analysis/seizing-initiative-ukraine-waging-war-defense-dominant-world.

The Ukrainian counteroffensive managed to achieve limited gains but was not an overwhelming success. This was probably due to Ukraine's choice to minimise the risk of heavy losses by carrying out a concentrated counterattack and rather opt for launching offensives across three axis (Zaporizhzhia, Berdiansk, Bakhmut).[106] Additionally, the Ukrainians were unable to sufficiently make use of the time as the need to train troops, receive weapons and ammunitions from the West, delayed their response. During this time window Russia was able to prepare for the counterattack.[107]

Russia used its inherent size advantage in terms of raw numbers of soldiers and production lines, as well as brute force. The strength of its engineering branches allowed the army to hold land in the face of the Ukrainian counteroffensive. Ukraine's offensive operations were massively challenged by Russian construction of complex obstacles and field fortifications across the frontline, such as concrete reinforced trenches and command bunkers, wire entanglements, hedgehogs, anti-tank ditches, and complex minefields. Mine laying also fundamentally contributed to attrition warfare in the third phase of the war. Russian minefields did not follow a discernible pattern, were rarely marked, and employed both anti-tank and anti-personnel mines. The use of drones for constant surveillance of minefields allowed the Russians to detect and target mine-clearance vehicles and armoured columns.[108]

While Russian minefields helped to hold ground during the counteroffensive, Russia performed decidedly worse in breaching Ukraine's mine belts.[109] Additionally, despite good preparation, the extensive front meant Russia lacked the force-to-space ratio to defend such an expansive frontline, with Ukraine managing to thin out its defensive positions in some areas (e.g. Belgorod Oblast).[110] Another weak spot of the Russian army remained the inefficient use of its massive ammunition stockpile, exceeding its manufacturing rate of both barrels and shells. As the Russians used firepower to compensate for tactical shortcomings in other areas, shortages of ammunition were the greatest threat.[111]

The Battle of Bakhmut in May 2023 exemplifies the conduct of war in this phase of the conflict. After months of intense attritional warfare, Russian troops, heavily supported by Wagner Group mercenaries, succeeded in capturing the city. This marked a symbolic victory for Russia, as the strategic value of Bakhmut remained questionable, since the capture of the city did not translate into broader operational advantages. The Russian success in capturing Bakhmut was largely built on its use of sheer mass and brute force and is emblematic of the attritional character of the war in this phase. Moreover, the cost of the battle for Bakhmut was exceptionally high, with severe depletion of Russian manpower and resources.[112]

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106 Zafra and McClure, 'Mapping Ukraine's Counteroffensive'.

107 Tara Copp, 'Why Ukraine's Spring Offensive Still Hasn't Begun — with Summer Just Weeks Away', Associated Press, 19 May 2023, https://apnews.com/article/ukraine-russia-counteroffensive-war-attack-b962a-ba2b779044d22b11dab719f1614.

108 Seth G. Jones, Alexander Palmer, and Joseph S. Bermudez Jr., 'Ukraine's Offensive Operations Shifting the Offense-Defense Balance' (CSIS, June 2023), https://csis-website-prod.s3.amazonaws.com/s3fs-public/2023-06/230609_Jones_Ukraine_Operations.pdf?VersionId=50OXVua.QRT58vSgSUc99VMMb-FRo3YUp; Zafra and McClure, 'Mapping Ukraine's Counteroffensive'; Watling and Reynolds, 'Meatgrinder', 23 February 2024.

109 Watling and Reynolds, 'Meatgrinder', 23 February 2024, 10.

110 Jones, Palmer, and Bermudez Jr., 'Ukraine's Offensive Operations Shifting the Offense-Defense Balance'.

111 David Hambling, 'When Will Ammunition Shortage Silence Russia's Artillery?', Forbes, 5 April 2023, https://www.forbes.com/sites/davidhambling/2023/04/05/when-will-ammunition-shortage-silence-russias-artillery/.

112 Katerina Stepanenko, 'The Kremlin's Pyrrhic Victory in Bakhmut: A Retrospective on the Battle for Bakhmut' (Institute for the Study of War, 24 May 2023), http://dev-isw.bivings.com/.

The Ukrainian counterattack was also slowed down by the terrain. In the southeastern territories, wide-open fields between cities left little room for cover for Ukrainian troops, tanks and armoured vehicles; while trees lining the perimeters of these fields allowed Russia to conceal its forces and hide them from aerial observation, also thanks to the skilful use of counter UAV means. Additionally, as Russia consolidated its presence in small villages, it used these settlements as man-made obstacles for Ukraine's counterattacks.[113] Notably, the breach in the Nova Kakhova dam in June posed an obstacle to Ukraine's counteroffensive. Ukraine's military leadership was forced to change plans given that the creation of large drowning fields, swamped farmland and marshlands made it even harder to cross over, dig trenches in, and fight on.[114]

3.5. **Stalemate** (October 2023 – November 2024)

After the summer counteroffensive, the war entered a stalemate phase, during which the frontline barely moved. From October onwards 2023, Russia focused a series of attacks on the city of Avdiivka, a gateway for Ukraine to Donetsk. Notably, the Russians managed to seize the city of Avdiivka in February 2024, marking the biggest change in the frontline since May 2023.[115]

This fourth phase of the war highlighted Ukraine's lack of sufficient equipment, particularly weapons of its own (given the US ban on using American weapons on Russian territory) to attack facilities in Russia from which strikes on its territory are launched.[116] Ukraine was and continues to be in desperate need of shells and artillery ammunition as a consequence of dwindling Western provisions. These shortages in combination with shortages in manpower largely prevented Ukraine from initiating offensive operations.

Despite Russia holding "material, industrial, and manpower advantages in 2024, along with the initiative," it made similarly little progress between October 2023 and January 2024.[117] Russia was able to replace its losses in terms of manpower through mobilising reserves and contract soldiers. This allowed it to hold territory despite low morale. Superior numbers of manpower were important nonetheless. In fact, Russia was able to conduct a series of smaller tactical attacks that, while not moving the front line, maintained constant pressure and inflicted steady losses on Ukraine.[118]

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113 Thomas Gibbons-Neff, Josh Holder, and Marco Hernandez, '21 Miles of Obstacles', *The New York Times*, 28 June 2023, sec. World, https://www.nytimes.com/interactive/2023/06/28/world/europe/ukraine-counteroffensive-obstacles.html.

114 Mike Eckel, 'After The Flood: What We Know About The Destroyed Ukrainian Dam And Its Consequences', *Radio Free Europe/Radio Liberty*, 10:13:27Z, sec. Ukraine, https://www.rferl.org/a/ukraine-kakhovka-dam-collapse-explainer-consequences/32447530.html.

115 Nuray Bulbul Davison Tamara, 'Timeline of the Russia-Ukraine War as Two-Year Anniversary Nears', Evening Standard, 7 February 2024, https://www.standard.co.uk/news/world/timeline-russia-ukraine-war-invasion-two-year-anniversary-b1062060.html; 'Ukraine Conflict Updates 2023', Institute for the Study of War, 2023, http://dev-isw.bivings.com/.

116 William Courtney and Peter A. Wilson, 'Upping the Ante on Western Weapons Could End the Stalemate in Ukraine', 30 January 2024, https://www.rand.org/pubs/commentary/2024/01/upping-the-ante-on-western-weapons-could-end-the-stalemate.html.

117 Michael Kofman, Rob Lee, and Dara Massicot, 'Hold, Build, and Strike: A Vision for Rebuilding Ukraine's Advantage in 2024', War on the Rocks, 26 January 2024, https://warontherocks.com/2024/01/hold-build-and-strike-a-vision-for-rebuilding-ukraines-advantage-in-2024/.

118 Jack Watling and Nick Reynolds, 'Russian Military Objectives and Capacity in Ukraine Through 2024', RUSI, 26 February 2024, https://rusi.orghttps://rusi.org.

Notably, in August 2024, Ukraine launched an offensive into the Russian oblast of Kursk, bringing the ground fight to Russian territory for the first time. Ukrainian forces successfully breached well-fortified Russian defensive positions around Kursk, which included minefields, anti-tank obstacles, and entrenched artillery, declaring the capture of 1,000 square kilometres of Russian territory.[119] They were able to do so by applying combined arms tactics, using mechanised units and precision strikes to disrupt Russian supply lines and rear-echelon operations. Most notably, Ukrainian forces employed air defence systems to reduce Russian ISR and electronic warfare to target and degrade Russian C4ISR capabilities.[120] Ukrainian forces capitalised on the element of surprise, managing to penetrate 30 kilometres into Russia and capturing hundreds of Russian soldiers used in exchanges for Ukrainian prisoners of war.[121] The offensive allowed Ukraine to increase its operational reach, and target Russia's fuel depots, an oil refinery, as well as destroying key supply bridges.[122] While these operations did not shift the stalemate, they contributed to weakening Russia's supply to its mechanised units while uplifting Ukrainian morale.[123]

However, two months after the initial Ukrainian breach, Russia regained its footing, reclaiming about one-third of the occupied territories by the end of October.[124] To achieve this, Russia relied on the use of overwhelming manpower and brute force. It redeployed over 50,000 troops to the region, not enough to weaken Russian offensive operations on the eastern front, which was said to be one of the main strategic objectives for Ukraine.[125] Despite suffering reportedly as many as 2,000 casualties a day, Russian forces still advanced thanks to their numerical superiority.[126] Notably, Russian numbers were strengthened by around 12,000 North Korean servicemen, reportedly only in support roles but in December 2024 also in fighting roles.[127] At the end of November 2024, Russia had reclaimed 40% of the Kursk territory, showing once more the importance of manpower in attritional warfare. Ukraine's goal to relieve pressure on the eastern front appeared to have failed. Figure 5 shows the status of the invasion as of 30 November 2024.

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119 John Hardie, 'What Ukraine's Kursk Gamble Has — and Has Not — Achieved', FDD, 8 November 2024, https://www.fdd.org/analysis/2024/11/08/what-ukraines-kursk-gamble-has-and-has-not-achieved/; John V. Parachini, 'The Kursk Offensive: Triumph or Tragedy in the Making?' (RAND, 17 September 2024), https://www.rand.org/pubs/commentary/2024/09/the-kursk-offensive-triumph-or-tragedy-in-the-making.html.

120 Dorsel Boyer and ISC Robert K Becker, 'How Ukraine Overcame The Transparent Battlefield To Achieve Operational Surprise In Kursk', Tradoc G2, 19 September 2024, https://oe.tradoc.army.mil/2024/09/19/how-ukraine-overcame-the-transparent-battlefield-to-achieve-operational-surprise-in-kursk/.

121 Hardie, 'What Ukraine's Kursk Gamble Has — and Has Not — Achieved'.

122 Dan Cox, 'The Operational and Strategic Genius of the Kursk Offensive' (Foreign Policy Research Institute, 22 November 2024), https://www.fpri.org/article/2024/11/the-operational-and-strategic-genius-of-the-kursk-offensive/; Kevin Shalvey, 'Russian Supply Bridges Destroyed by Ukraine amid Kursk Incursion, Kyiv Says', ABC News, 18 August 2024, https://abcnews.go.com/International/russian-supply-bridges-destroyed-ukraine-amid-kursk-incursion/story?id=112925749.

123 Cox, 'The Operational and Strategic Genius of the Kursk Offensive'.

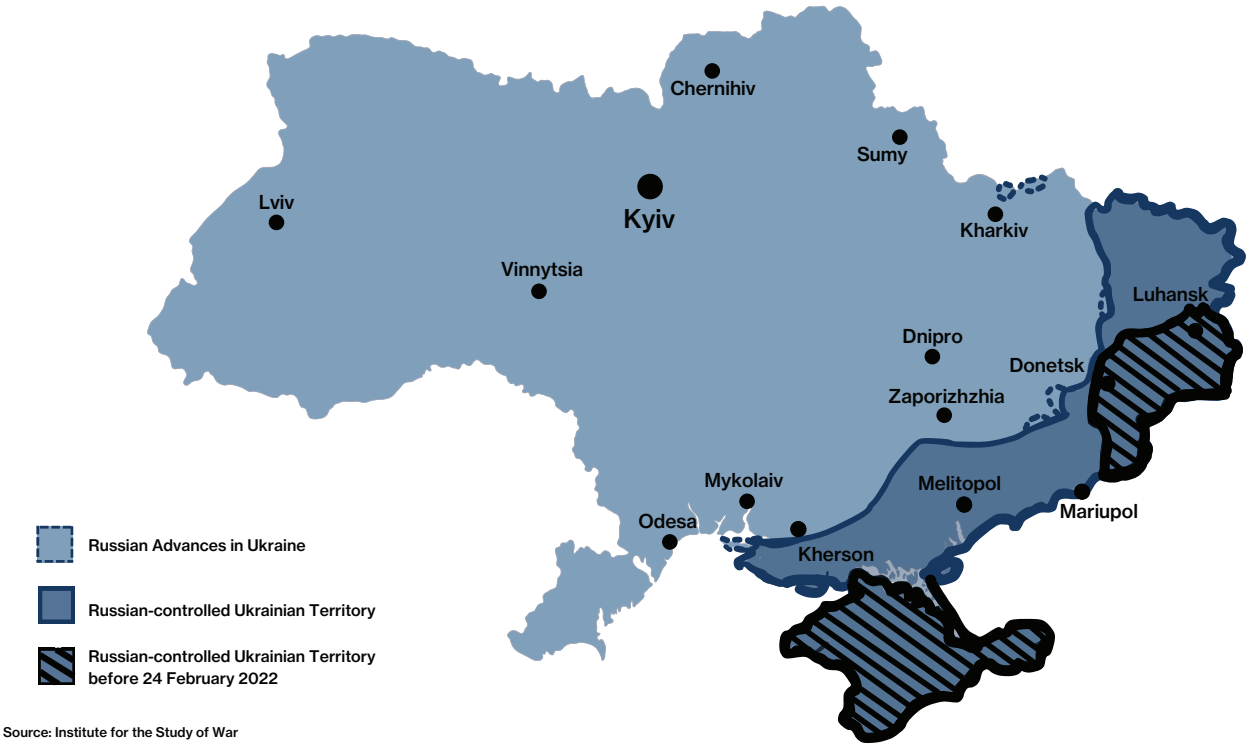
124 Hardie, 'What Ukraine's Kursk Gamble Has — and Has Not — Achieved'.

125 Ann Marie Dailey, 'Ukraine's Kursk Offensive: Geometry, Not Geography' (RAND, 17 September 2024), https://www.rand.org/pubs/commentary/2024/09/ukraines-masterstroke-kursk-offensive-is-about-geometry.html; Katie Bo Lillis Bertrand Natasha, 'Russia Appears to Have Diverted Several Thousand Troops from Occupied Ukraine to Counter Kursk Offensive, US Officials Say | CNN Politics', CNN, 15 August 2024, https://www.cnn.com/2024/08/15/politics/russia-has-diverted-several-thousand-troops-from-occupied-ukraine-to-counter-kursk-offensive-us-officials-say/index.html.

126 Kieran Kelly and James Kilner, 'Russia "Suffering 2,000 Casualties a Day" as War's Kursk Counter-Offensive Falters, Ukraine Claims', *The Telegraph*, 12 November 2024, https://www.telegraph.co.uk/world-news/2024/11/12/ukraine-russia-kursk-offensive-latest-news/; Olena Harmash, 'Ukraine Has Lost over 40% of Land It Seized in Russia's Kursk Region, Senior Kyiv Military Source Says', *Reuters*, 24 November 2024, sec. Europe, https://www.reuters.com/world/europe/ukraine-has-lost-over-40-russias-kursk-region-counter-attacks-senior-kyiv-2024-11-23/.

127 Can Kasapoğlu, 'Kremlin, With Help From North Korea, Stages Major Push To Recapture Russian Region Of Kursk – Analysis', Eurasia Review, 15 November 2024, https://www.eurasiareview.com/15112024-kremlin-with-help-from-north-korea-stages-major-push-to-recapture-russian-region-of-kursk-analysis/.

Figure 5. Status of the Russian invasion in Ukraine as of 30 November 2024



Source: Institute for the Study of War

The reclaiming of Kursk territory was only one of the instances of Russian gradual encroachment. In fact, in the latter part of this phase of the conflict, Russian forces demonstrated a pattern of incremental territorial encroachment in eastern and southern Ukraine, relying on attrition to consolidate control over contested regions.[128] Despite heavy losses and operational setbacks, Russia achieved limited but significant gains, particularly in the Donetsk and Luhansk oblasts, leveraging artillery firepower and manpower. The advance was marked by the systematic targeting of infrastructure and civilian areas to weaken resistance and disrupt supply chains.[129] Furthermore, Russia's actions in the Zaporizhzhia region during the summer, including its entrenchment near critical nodes like Enerhodar, included, once more, the targeting of energy infrastructure in the months preceding winter.[130] Even if Russia failed to break the strategic deadlock, its incremental progress highlighted once again the critical importance of being able to replenish the ranks and resupply materiel in a war attrition.

128 'Ukraine Conflict Updates', Institute for the Study of War, 2024, http://dev-isw.bivings.com/.

129 Brendan Cole and John Feng, 'Ukraine War Maps Reveal Russian Advances across Front Line', Newsweek, 28 November 2024, https://www.newsweek.com/russia-ukraine-maps-isw-1992965.

130 'Russia Pounds Ukraine's Zaporizhzhia City with Guided Bombs, Injures 16', *Reuters*, 29 September 2024, sec. Europe, https://www.reuters.com/world/europe/russia-pounds-ukraines-zaporizhzhia-city-with-guided-bombs-injures-16-2024-09-29/; 'IAEA Urges Halt to Attacks on Town near Ukrainian Nuclear Plant', *Reuters*, 23 June 2024, sec. Europe, https://www.reuters.com/world/europe/iaea-urges-halt-attacks-town-near-ukrainian-nuclear-plant-2024-06-23/.

4. The Battle for Ukrainian Airspace

How applicable are lessons from the air domain over Ukraine to a war over Taiwan , especially when neither Russia nor Ukraine had conventional air superiority for a prolonged period during the first year of the war? How can the role of electronic warfare be adequately considered in this domain? And what was the contribution of Integrated Air and Missile Defence (IAMD) assets to creating a situation of mutual air denial?

Analysts in the early war period were surprised by the poor performance of the Russian aerospace forces (VKS), particularly by their inability to coordinate effectively with land forces and their failure to establish even short-term air superiority over key areas including Hostomel. The VKS also suffered a lack of manpower. As it quickly ran through its pilots' flight times, retired general officers were called up to join to supplement its pilot force.[131] The Ukrainian Air Force performed much better but were also unable to maintain established control over Ukraine's airspace. Although they were able to effectuate a situation of air denial against the VKS they were not able to create advantages that could support other forces.

The VKS' poor performance ran counter to many pre-war expectations, given the purported importance of C4ISR assets and long-range attack platforms in the post-2008 Russian military reforms.[132] Relatedly, the performance of the Ukrainian forces, with external intelligence support, to utilise a relatively limited number of air and missile defence assets so effectively surprised some observers.[133]

This chapter focuses exclusively on the air domain of the ongoing invasion, with a particular emphasis on the use of unmanned systems (drones), IAMD, and fixed- and rotary-wing assets.

On paper, Russia had all the advantages to prevail over Ukraine in the air domain.

4.1. Invasion and its repellence (December 2021 – July 2022)

In the first phase of the war, Russia failed to establish air superiority, despite superior numbers and capabilities (Figure 2). To understand the reasons behind Russia's failure to complete its suppression of enemy air defences (SEAD) and establish air superiority, it is necessary to consider both Russia's shortcomings and Ukraine's prowess in its use of (scarce) resources.

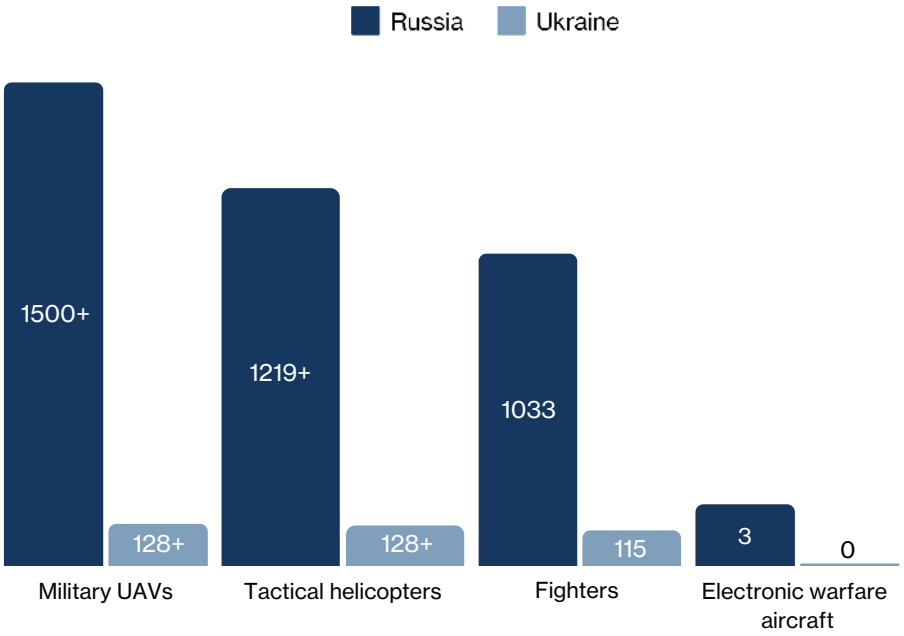
131 'Russian Major General Shot Down Over Ukraine', The Moscow Times, 24 May 2022, https://www.themoscowtimes.com/2022/05/24/russian-major-general-shot-down-over-ukraine-bbc-russian-a77788.

132 Jonsson, 105-110.

133 Paul van Hooft and Lotje Boswinkel, 'Surviving the Deadly Skies: Integrated Air and Missile Defence 2021-2035' (The Hague Centre for Strategic Studies, 1 December 2021), https://hcss.nl/report/surviving-the-deadly-skies/.

On paper, Russia had all the advantages to prevail over Ukraine in the air domain. At the beginning of the war, the balance of capabilities was decidedly in Russia's favour. Ukraine was outnumbered (up to 15:2 in some cases), outgunned, and technologically outmatched. In fact, Russia could count on a much larger and more modern arsenal of aircraft and missiles while Ukraine relied mostly on legacy systems and older 4th generation fighters, such as the SU-series and Mig-29s.[134]

Figure 6. Pre-war balance of air capabilities between Russia and Ukraine



Source: The Military Balance

Russian air superiority failed to materialise due to serious issues related to planning, targeting, and communication and information integration, as described in the previous chapters. In the first week of the invasion, Russia followed a conventional aerial offensive targeting Ukrainian air defence capabilities and stockpiles, defence industry, and communication infrastructure in key cities.[135] However, the strikes led to limited serious damage because of two main targeting-related reasons. First, while accurate, Russian strikes targeted sites that had been mapped in the months prior to the war by Russian intelligence. By the time of the attack, however, Ukrainian forces had moved their mobile air defence systems, dispersing them with the aid of US intelligence. Ukrainian forces also relocated most of their munition stocks and aircraft in the hours before the invasion. Consequently, Russian missiles struck outdated sites and due to Ukraine's efficient use of mobility and dispersion mainly hit older static SA-3 Surface to Air Missiles (SAM) sites and several S-300PS/PT SAM transporter erector

134 Justin Bronk, Nick Reynolds, and Jack Watling, 'The Russian Air War and Ukrainian Requirements for Air Defence', 7 November 2022, https://rusi.org; Kartik Bommakanti, 'The Military Lessons of the Russia-Ukraine War', Special Report (Observer Research Foundation, January 2024), https://www.orfonline.org/public/uploads/posts/pdf/20240119104743.pdf.

135 Bowen, 'Russia's War in Ukraine: Military and Intelligence Aspects', 4.

launchers.[136] Second, Russia failed to hit critical C2 nodes similarly due to outdated data, allowing Ukrainian air and air-defence capabilities to conduct defensive operations.[137]

A lack of communication between Russia's air and ground forces also contributed to Russia's failure to establish air superiority. Russia did not integrate tactical intelligence with lacking or deficient feedback loops between forward air control and target selection. This prevented the swift adjustment of targeting instructions. Additionally, while Russian EW was initially successful in jamming Ukrainian radar communication systems, it soon hampered Russian forces' own communications.[138]

On the Ukrainian side, the armed forces were able to mount an effective defence despite their more limited resources. The heavy use of Man-Portable Air-Defence Systems (MANPADS) to target low-flying VKS fixed- and rotary-wing assets proved successful, leading to heavy losses among those forces.[139] Alongside MANPADS, Ukrainian forces rapidly integrated various drone systems across different levels to supplement a weaker air footprint. This was particularly impactful in targeting the long convoy of tanks, armoured personnel carriers (APCs), and supply trucks that were bogged down across northern Ukraine in the first weeks of the war. Deployments of the Turkish TB-2 *Bayraktar* system, which had been so devastating when used by the Azeri against Armenian forces in Nagorno-Karabakh in 2020, were especially effective in slowing down tank manoeuvres.

On the more traditional air defence front, Ukraine's use of a variety of mobile air-defence systems such as S-300s, IRIS-T, and Pantsir, using 'shoot and scoot' tactics proved highly effective against VKS attacks both against aircraft and in missile defence.[140] 'Shoot and scoot' refers to an IAMD battery firing off a salvo before quickly changing location before the enemy can find and attack it.[141] By the summer 2022, interception rates of incoming cruise missiles and Russian aircraft losses had increased markedly.[142]

As the first phase of the war wound down, and the initial Russian assaults in the north failed, the VKS shifted from a conventional aerial offensive to a more unconventional mix of drone, cruise missile, and ballistic missile attacks to target deep inside Ukraine and increase attacks against civilian targets. Russia deployed drones to target IAMD batteries to overwhelm defences, followed by heavy cruise and ballistic missile salvoes against civilian areas. This was both devastating for the civilian population and its infrastructure and difficult for the Ukrainian

136 Frans Osinga, 'Putin's War, a European Tragedy: Why RUssia's War Failed and What It Means for NATO', in *Reflections on the Russia-Ukraine War*, Maarten Rothman, Lonneke Peperkamp, and Sebastiaan Rietjens (Leiden University Press, 2024), 123–46, http://www.jstor.org/stable/jj.13760045.10; Justin Bronk, Nick Reynolds, and Jack Watling, 'The Russian Air War and Ukrainian Requirements for Air Defence' (The Royal United Services Institute (RUSI), 7 November 2022), 9, 26–27, https://rusi.org.

137 Tyson Wetzel, 'Ukraine Air War Examined: A Glimpse at the Future of Air Warfare', *Atlantic Council* (blog), 30 August 2022, https://www.atlanticcouncil.org/content-series/airpower-after-ukraine/ukraine-air-war-examined-a-glimpse-at-the-future-of-air-warfare/.

138 Frans Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO', in *Reflections on the Russia-Ukraine War*, ed. Maarten Rothman, Lonneke Peperkamp, and Sebastiaan Rietjens (Leiden University Press, 2024), 123–46, https://doi.org/10.24415/9789087284343.

139 Mykhaylo Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022', Royal United Services Institute (RUSI), 30 November 2022, 35, https://rusi.orghttps://rusi.org; Bommakanti, 'The Military Lessons of the Russia-Ukraine War', 8; Watling and Reynolds, 'Russian Military Objectives and Capacity in Ukraine Through 2024', 20.

140 Bommakanti, 'The Military Lessons of the Russia-Ukraine War', 8.

141 Bronk, Reynolds, and Watling, 'The Russian Air War and Ukrainian Requirements for Air Defence', 7 November 2022, 26.

142 David Rising and Hanna Arhirova, 'Western Weapons, Experience Harden Ukrainian Air Defenses against Russian Onslaught', Associated Press, 11 May 2023, https://apnews.com/article/ukraine-russia-war-air-defenses-3f0a918c617534251e53da4a93121c42.

air defence forces, which by this stage had to balance both military force protection tasks and the civilian protection mission.[143] On both the Ukrainian and Russian sides, the availability of munitions began to become a concern, as the scale of Russian salvoes and Ukraine's counter defences expended stockpiles on both sides quickly.

4.2. **Consolidated Defence** (August 2022 – February 2023)

Unsurprisingly, both sides adapted after the initial dynamic phase of the war transitioned into a more static situation. In this second phase, the role of traditional air combat platforms remained limited, while the use of drones and missiles continued to increase as both sides integrated these capabilities more systematically within their modus operandi. As both adapted, the situation of mutual air denial persisted, with the Russians unable to bring their air forces fully to bear in the face of Ukrainian air defence and the Ukrainians unable to use their air assets to support ground operations. This second aspect would become more problematic in the latter phases of the war, as Ukrainian adaptation came to embody NATO tactics that rely on air superiority.

The first notable change in this phase of the war was the improvement of Russian tactical air defences that protected Russia's forces. Enhanced situational awareness, achieved through better integration of long-range and all-altitude radar systems, significantly bolstered the effectiveness of Russian short-range air defence (SHORAD) units. These advancements allowed for higher interception rates against threats such as High-Speed Anti-Radiation Missiles (HARMs) and Guided Multiple Launch Rocket System (GMLRS) munitions supplied by Western allies to Ukraine.[144]

Still, Russia's biggest challenge remained resource constraints. By late 2022, it became clear that Russia's stockpile of precision munitions was on the verge of depletion resulting in widespread shortages due to stockpiling limitations.[145] This constraint, compounded by inadequate domestic production capacity, forced a strategic pivot in Moscow's prosecution of its aerial campaign. The focus shifted to the intermittent use of coordinated barrages involving cruise missiles, ballistic missiles, and loitering munitions. These operations aimed to overwhelm Ukrainian defences through sheer volume, despite diminishing fire rates and loss of operational tempo.[146]

Central to this new strategy was the mass use of Shahed-136 drones, supplied by Iran. These low-cost, loitering munitions were deployed in large numbers, creating operational challenges for Ukraine's air defence systems. Their affordability allowed for sustained waves of attacks that exhausted Ukrainian missile stockpiles, even though many drones were intercepted.

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143 Bronk, Reynolds, and Watling, 'The Russian Air War and Ukrainian Requirements for Air Defence', 7 November 2022, 28.

144 Jack Watling and Nick Reynolds, 'Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine', 19 May 2023, 20, https://rusi.orghttps://rusi.org.

145 Jake Epstein, 'Russia Is Tearing through Its Munitions Stockpiles Faster than It Can Refill Them, Top US Intel Chief Says', Business Insider, 5 December 2022, https://www.businessinsider.com/russia-uses-munitions-stockpiles-faster-than-replacing-them-us-intelligence-2022-12.

146 Michael Wasiura, 'Russia Using Up Missile Stockpiles "For No Militarily Meaningful Purpose"', Newsweek, 11 October 2022, https://www.newsweek.com/russia-using-missile-stockpiles-no-militarily-meaningful-purpose-1750858.

Alongside these swarms, Russia continued to deploy more sophisticated weaponry such as Kh-101 and Kalibr cruise missiles, as well as Iskander ballistic missiles, targeting critical infrastructure in Ukrainian cities.[147]

Russian strategic adaption did not limit itself to the employment of certain capabilities, but it encompassed a shift in targeting as well.

Russian strategic adaption did not limit itself to the employment of certain capabilities, but it encompassed a shift in targeting as well. In fact, a defining feature of this second phase was the escalation of attacks against civilian energy infrastructure, rather than Ukrainian air defence capabilities and stockpiles, the primary targets of Russia's aerial campaign in the first phase. As winter closed in, Russia prioritised strikes on power grids, substations, and other energy-related facilities. This type of targeting sought to degrade Ukraine's resilience and erode civilian morale by plunging communities into darkness and cold during the harshest winter months. The operational execution of this strategy blended cheap, mass-produced loitering munitions with precision strikes. Shahed-136 drones targeted substations and smaller facilities, while cruise and ballistic missiles struck larger power stations and grid nodes. This multi-layered approach caused serious damage to Ukraine's energy systems, even as Ukrainian air defences successfully intercepted many incoming threats.[148]

In response to the shift in Russian air strategy as well as its own troubles with dwindling stockpiles, Ukraine adapted its air-defence tactics while also investing in indigenous drone capabilities. Recognising the cost and logistical burden of defending against sustained drone and missile attacks, Ukraine began developing and deploying long-range kamikaze drones of its own, such as the Bober and UJ-22.[149] These drones represented a shift toward asymmetric capabilities that allowed Ukraine to carry out counter-strikes against Russian positions. By bolstering domestic production of cheap drones, Ukrainian forces demonstrated resilience in managing limited resources, even as the high volume of Russian drone and missile attacks placed significant strain on their air defence systems.

The second phase of the war was characterised by shortages that pushed strategic shifts in the use of capabilities. For Russia, munitions shortages necessitated a shift toward lower-cost, high-volume systems like the Shahed-136, which could sustain the campaign despite reduced firepower. For Ukraine, the sheer scale of incoming attacks created pressures on its air defence missile stockpiles, forcing careful prioritisation of targets and increasing domestic production of cheap, smaller drones.

4.3. **Counterattack** (March 2023 – September 2023)

The third phase of the war saw a continuation of the tactics employed during the second phase and an overall limited role of air forces. Drones continued to feature dominantly in tactical combat, reconnaissance, and strike situations, in combination with missile attacks on energy grids and cities.

Ukraine's reliance on drones continued in this phase of the war, proving fundamental to hitting Russian targets in Ukraine and also in Russia itself. Notably, domestically produced UAVs,

147 Bommakanti, 'The Military Lessons of the Russia-Ukraine War,' 9; Bronk, Reynolds, and Watling, 'The Russian Air War and Ukrainian Requirements for Air Defence,' 30-34.

148 Bronk, Reynolds, and Watling, 'The Russian Air War and Ukrainian Requirements for Air Defence,' 1, 34.

149 Bommakanti, 'The Military Lessons of the Russia-Ukraine War'.

supplemented by Western-supplied systems such as the American *Switchblade* loitering munitions, targeted Russian logistics hubs and airbases, including in successful operations in Crimea.[150] While these strikes disrupted Russian supply chains and exposed vulnerabilities, they were insufficient to fundamentally shift the balance of air power. Russia countered these efforts with increasingly sophisticated EW systems.[151] Low-signature EW capabilities proved highly effective in detecting and neutralising Ukrainian UAVs, while deception tactics, such as generating fake UAV signals, further undermined Ukraine's drone-based strategies.[152]

Russia continued to adapt its approach experimenting with standoff tactics that proved to be quite successful. Air-launched cruise missiles (ALCMs) constituted the majority of Russian strikes, allowing forces to target Ukrainian infrastructure and military positions from beyond the range of air defences. These strikes were often combined with, again, the deployment of Iranian-supplied Shahed-136 drones, creating a multi-layered attack strategy aimed at overwhelming Ukrainian defences.[153] This approach, while effective in targeting infrastructure, also revealed Russia's need to conserve its aerial assets by minimising exposure to contested airspace.

Thus, this phase of the war features Ukraine's continuous reliance on drones and precision strikes. At the same time, Russia's deployment of advanced EW systems and its focus on standoff capabilities underscored the strategic importance of both electronic warfare and long-range precision weapons. Furthermore, the challenges faced by both sides in maintaining effective air defences revealed the strain of protracted conflict and the need for adaptable, layered systems to counter evolving threats.

4.4. **Stalemate** (October 2023 – November 2024)

The fourth phase of the war has been characterised by the increase of Russian air strikes against Ukraine's cities and energy infrastructure, with the Ukrainian Air Force (UAF) nonetheless managing to successfully intercept and repel a considerable amount of these attacks.

In the biggest aerial barrage of the war to date, Russia launched 122 missiles and 36 Shahed drones across Ukraine in December 2023, killing at least 58 civilians and injuring more than 160.[154] The attack targeted the capital of Kyiv, as well as the cities of Lviv, Dnipro, Odesa, Zaporizhzhia, Smila, Kharkiv, and Khmelnytskyi, with Russia making full use of its military arsenal by deploying hypersonic air-launched ballistic Kinzhal missiles, S-300s, cruise missiles, and 18 strategic bombers launching X-101 and X-505 missiles.[155] Ukrainian forces

150 Jones, McCabe, and Palmer, 'Seizing the Initiative in Ukraine: Waging War in a Defense Dominant World'.

151 Duncan McCrory, 'Electronic Warfare in Ukraine' (Joint Air Power Competence Centre, 7 October 2023), https://www.japcc.org/articles/electronic-warfare-in-ukraine/; Watling and Reynolds, 'Meatgrinder', 19 May 2023.

152 Watling and Reynolds, 'Meatgrinder,' 18-19.

153 Can Kasapoglu, 'Assessing Ukraine's Air Defense Deterrent' (Hudson Institute, 5 November 2024), https://www.hudson.org/assessing-ukraine-air-defense-deterrent-can-kasapoglu.

154 'Масований удар по Україні: Львів, Київ, Дніпро, Харків, Запоріжжя, Сміла - багато загиблих і поранених', BBC News Україна, 29 December 2023, https://www.bbc.com/ukrainian/articles/czkjyp9g9ymo.

155 Vogt Adrienne et al., 'December 29, 2023 - Russia Launches Largest Air Attack on Ukraine since Full-Scale Invasion', CNN, 29 December 2023, https://www.cnn.com/world/live-news/russia-ukraine-war-12-29-23/index.html.

managed to destroy 27 Shaheds and 87 of the Kh-101, Kh-555 and Kh-55 cruise missiles, but were not able to intercept or destroy any of the ballistic missiles.[156] In February of 2024, Russian forces also established limited and localised air superiority during the Avdiivka offensive, by launching a barrage of KAB glide bombs which, for the first time, provided air support to advancing infantry troops on the ground.[157]

At the end of March 2024, Russia launched the largest attack on Ukraine's energy infrastructure since the beginning of the war.[158] The assault, carried out with 88 missiles and 63 Shahed drones, primarily targeted power plants and energy supply lines in the south-eastern Dnipropetrovsk region, hitting and damaging the Dnipro Hydroelectric Station, one of Europe's largest. In response, the UAF managed to shoot down 37 missiles and 55 drones, but the attacks left one million people without electricity, and led DTEK, Ukraine's largest private electricity company, to lose 80% of its generating capacity.[159] For the first time, Russia did not deny the deliberate targeting of civilian infrastructure but instead vowed to destroy it in retaliation for Ukraine's most recent incursions into Russia.[160]

In this period, Ukrainian drone strikes hit increasingly distant targets deep within Russian territory. These attacks were primarily carried out through the use of drones with longer ranges and novel yet basic forms of artificial intelligence (AI), which enhanced navigational abilities while hindering Russia's jamming and spoofing attempts.[161] At the beginning of March 2024, Ukraine struck three Russian oil refineries in the cities of Ryazan, 200 km southeast of Moscow; Kstovo, 500km east of the capital; and Kirishi, distant 650km from Russia's political centre.[162] The three facilities are among Russia's largest refineries, and were targeted in order to damage Russia's oil and gas industry, which has remained the biggest source of revenue for the Russian government.[163] Ukrainian drones struck again on March 18th, the final day of Russia's presidential vote, and were destroyed over the Kaluga and Yaroslavl regions, with the latter group having penetrated almost 800km into Russian territory. In April, Ukraine launched what appeared to be its deepest drone strike inside Russia since the beginning of the war, hitting the Nizhnekamsk oil refinery situated in the Tatarstan region, more than 1,100 km away from Ukraine's borders.[164]

The heightened precision of Ukrainian drones is attributed to the inclusion of a terminal computer in each aircraft, equipped with satellite and terrain data, allowing the aircraft to

156 'Масований удар по Україні'.

157 Grace Mappes et al., 'Russian Offensive Campaign Assessment, February 17, 2024', Institute for the Study of War, 17 February 2024, http://dev-isw.bivings.com/.

158 Christopher Miller and Polina Ivanova, 'Russia Targets Ukraine's Energy Infrastructure in Major Strike', 22 March 2024, https://www.ft.com/content/5f9a1eb3-2ddc-484e-bf11-9e03ff1ba92b.

159 Pjotr Sauer, 'Over 1m Ukrainians without Power after Major Russian Assault on Energy System', *The Guardian*, 22 March 2024, sec. World news, https://www.theguardian.com/world/2024/mar/22/over-1m-ukrainians-without-power-after-russias-largest-assault-on-energy-sector.; Tom Balmforth, 'Major Russian Air Strikes Destroy Kyiv Power Plant, Damage Other Stations', *Reuters*, 11 April 2024, sec. Europe, https://www.reuters.com/world/europe/russian-missile-strike-targets-cities-across-ukraine-2024-04-11/.

160 Sauer, 'Over 1m Ukrainians without Power after Major Russian Assault on Energy System'.

161 Allegra Goodwin, Claire Sebastian, and Vasco Cotovio, 'Ukraine's AI-Enabled Drones Are Trying to Disrupt Russia's Energy Industry. So Far, It's Working | CNN Business', CNN, 2 April 2024, https://www.cnn.com/2024/04/01/energy/ukrainian-drones-disrupting-russian-energy-industry-intl-cmd/index.html.

162 Rob Picheta, 'Ukraine Hits Oil Refineries Deep inside Russian Territory, as Kyiv Steps up Drone Attacks before Putin's Election', CNN, 13 March 2024, https://www.cnn.com/2024/03/13/europe/ukraine-russia-drone-strikes-putin-intl/index.html.

163 Goodwin, Sebastian, and Cotovio, 'Ukraine's AI-Enabled Drones Are Trying to Disrupt Russia's Energy Industry. So Far, It's Working | CNN Business'.

164 Katie Marie Davies, 'Ukraine Launches Far-Ranging Drone Attacks on Final Day of Russia Elections | AP News', 18 March 2024, https://apnews.com/article/russia-ukraine-war-drone-attack-f0e717ace1b9a4c286fe1d-2e112d74fe.

achieve "machine vision." AI models are reportedly trained to discern geographical features as well as pinpoint designated targets and the models are then built into the drone through a specialised chip. When deployed, these drones are completely autonomous, independently navigating their surroundings without reliance on satellite communication thanks to the preloading of their target coordinates.[165]

The trend towards autonomisation of these systems was the result of pervasive electromagnetic contestation. Weapons such as the High Mobility Artillery Rocket System (HIMARS) and Excalibur 155, an extended-range artillery projector, are both guided by satellite communication, making them particularly vulnerable to Russian jamming attempts.[166] In March 2024, for example, the targeting system for the GPS-guided Excalibur dropped from 70 per cent effectiveness to around 6 per cent, as new Russian EW mechanisms began emerging on the battlefield.[167]

Ukraine managed to resist and damage some of Russia's EW assets, such as in November 2023, when Ukraine's 59th Motorised Brigade took down the Pole-21 electronic warfare system located near Donetsk. Nonetheless, Russia retained an overall advantage in the EW realm.[168]

This last phase of the war has hence reiterated some of the takeaways from previous stages of the conflict, highlighting the importance of protecting both military and civilian targets, requiring significant investment in systems with high mobility and long range. Drones, both commercial and military-grade, also proved once more their value for ISR, targeting, and strikes, offering cost-effective solutions. At the same time, counter-UAVs and electronic warfare capabilities became increasingly vital to counter the growing threat of autonomised systems.

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165 Samuel Bendett, 'Roles and Implications of AI in the Russian-Ukrainian Conflict', Center for a New American Security, CNAS, 20 July 2023, https://www.cnas.org/publications/commentary/roles-and-implications-of-ai-in-the-russian-ukrainian-conflict; Margarita Konaev, 'Tomorrow's Technology in Today's War: The Use of AI and Autonomous Technologies in the War in Ukraine and Implications for Strategic Stability' (Center for Naval Analyses (CNA), September 2023), https://www.cna.org/reports/2023/10/ai-and-autonomous-technologies-in-the-war-in-ukraine.

166 Goodwin, Sebastian, and Cotovio, 'Ukraine's AI-Enabled Drones Are Trying to Disrupt Russia's Energy Industry. So Far, It's Working | CNN Business'.

167 Lauren Williams, 'Today's Battles Happen at the Pace of Software. The Pentagon Needs to Hit the Accelerator', Defense One, 13 March 2024, https://www.defenseone.com/defense-systems/2024/03/todays-battles-happen-pace-software-pentagon-needs-hit-accelerator/394925/.

168 Matthieu, 'Ukrainian UAV Strikes Russian Pole-21 Electronic Countermeasures Warfare System | Ukraine - Russia Conflict War 2022 | Analysis Focus Army Defence Military Industry Army', Army Recognition, 30 November 2023, https://www.armyrecognition.com/ukraine_-_russia_conflict_war_2022/ukrainian_uav_strikes_russian_pole-21_electronic_countermeasures_warfare_system.html.

5. Moving Over and Under the Sea

"Ukraine has shown that a combination of USVs, land-based missiles, and naval mines can deny a superior navy the ability to exercise sea control, at least in a relatively confined body of water."[169] This assessment from Scott Savitz and William Courtney essentially summarises a core lesson of the Russia-Ukraine war for the maritime domain. The ability to deny sea access along critical lines of communication can arrest the attackers' ability to take advantage of their maritime or amphibious capabilities. This is, of course, a basic tenet of naval theory. It shows that for the defender, it is not necessary to develop maritime dominance as long as the attacker is equally hobbled. This recognition can go a long way in shaping procurement decisions.

The pre-war imbalance between conventional naval capabilities between Russia and Ukraine was probably the greatest among all domains, with the navy being Ukraine's less developed military branch. At the beginning of the war, Russia's maritime capabilities outmatched Ukraine's quantitatively and qualitatively.[170] Despite this, Ukraine managed to innovatively use low-cost unmanned vehicles and land-based missiles to effectively create a situation of sea denial. In addition, the heavy mining of the Black Sea made it extremely hard for Russia to carry out an amphibious assault. Further, Russia failed to adequately protect its ships and naval bases, probably because it underestimated Ukrainian resourcefulness. Much can be learned from Ukraine's sea denial success despite the initial imbalance in conventional capabilities.[171] This chapter explores the course of the Russia-Ukraine war from the maritime perspective.

5.1. Invasion and its repellence (December 2021 – July 2022)

During the first phase of the war, Ukraine was able to deny Russia control of the Black Sea by scoring a series of successes in damaging and destroying Russian naval capabilities. These successes were the result of combining attacks from ground-launched long-range capabilities from ashore and UAVs as well as the employment of sea mines. Furthermore, Türkiye's invocation of the 1936 Montreux Convention to close the Bosporus and Dardanelles straits to warships in times of conflict also significantly influenced the maritime dynamics of the Ukraine war, especially in this first phase. By barring the passage of naval vessels from both Russia

169 Scott Savitz and William Courtney, 'The Black Sea and the Changing Face of Naval Warfare', *The RAND Blog* (blog), 31 October 2023, https://www.rand.org/pubs/commentary/2023/10/the-black-sea-and-the-changing-face-of-naval-warfare.html.

170 Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO'; Savitz and Courtney, 'The Black Sea and the Changing Face of Naval Warfare'.

171 Scott Savitz, 'The Age of Uncrewed Surface Vessels', 15 November 2022, https://www.rand.org/pubs/commentary/2022/11/the-age-of-uncrewed-surface-vessels.html; Bommakanti, 'The Military Lessons of the Russia-Ukraine War'.

and NATO, the closure effectively prevented Russia from reinforcing its Black Sea Fleet with assets such as the *Slava-class* cruisers RTS Marshal Ustinov from the Northern Fleet and RFS Varyag from the Pacific Fleet, limiting its capacity to project power and sustain operations. However, this decision also constrained NATO's ability to resupply Ukraine or protect critical Sea Lines of Communication (SLOCs) in the Black Sea.[172]

In the immediate aftermath of the invasion, Russia quickly gained control of the sea, having previously deployed two *Kilo*-class submarines, two cruisers, four destroyers and frigates, one corvette and six smaller naval vessels in the Eastern Mediterranean, and four *Kilo*-class submarines, one cruiser (the *Moskva*), two Frigates, one Corvette, and six amphibious assault vessels and their auxiliaries into the Black Sea.[173] The strategic pre-positioning of these assets demonstrated a calculated effort to try and establish maritime superiority. It reflected a deliberate strategy to hinder potential NATO countermeasures and support broader Russian military operations. The scale and composition of these deployments underscored the extent of Russia's preparation, reinforcing its initial intention to achieve command of the seas.[174]

Ukraine lost much of its naval force through missile attacks in the first week of the invasion including 10 patrol and gunboats, 11 out of 13 Ukrainian miscellaneous craft and its only amphibious vessel.[175] The Russian navy also heavily mined the Black Sea, with the FSB reporting that around 420 mines were floating in the Black Sea. Russia also relied on naval assets to carry out strikes on land-based targets in support of ground operations. On the first day of the invasion, Russian forces also captured Snake Island, a strategically important 40-acre rock formation owned by Ukraine a 300km west of Crimea.[176] Military control of this island affects shipping routes through and from Crimea and would allow for the installation of long-range defence systems to defend naval capabilities and attack Ukraine's coastline.[177]

However, Russian control of the sea did not last long, and Ukraine effectively succeeded in achieving sea denial near its coast. Ukraine exploited its defender's advantage and the vulnerability of Russian ships to attacks from ashore. The surface of the sea provides a simple background against which detecting and targeting are facilitated. Ukraine could hence use land-based capabilities such as mobile missile launchers to target surface vessels with the advantages of concealment and mobility. Russia, on the other hand, had little opportunities for cover or concealment in the open seas.[178] In addition to this, Ukraine also benefitted from inexplicably deficient Russian electronic warfare defence on the VMS vessels and Ukrainian ingenious use of both missiles unknown to Russian forces and unmanned surface vehicles (USVs).[179]

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172 Raul Pedrozo, 'THE RUSSIA-UKRAINE CONFLICT: Blocking Access to the Black Sea', *Naval War College Review* 75, no. 4 (Autumn 2022), 48.

173 Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO', 194.

174 Ben Hodges, Steven Horrel, and Ivanna Kuz, 'Russia's Militarization of the Black Sea: Implications for the United States and NATO', CEPA, 22 September 2022, https://cepa.org/comprehensive-reports/russias-militarization-of-the-black-sea-implications-for-the-united-states-and-nato/.

175 Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO', 194.

176 Sophie Williams and Paul Kirby, 'Ukraine War: Snake Island and Battle for Control in Black Sea', *BBC News*, 11 May 2022, sec. Europe, https://www.bbc.com/news/world-europe-61406808.

177 Antonia Colibășanu Scutaru Alexander Crowther, Joel Hickman, George, 'The Strategic Importance of Snake Island', CEPA, 27 September 2022, https://cepa.org/comprehensive-reports/the-strategic-importance-of-snake-island/.

178 Stephen Biddle and Ivan Oelrich, 'Future Warfare in the Western Pacific: Chinese Antiaccess/Area Denial, U.S. AirSea Battle, and Command of the Commons in East Asia', *International Security* 41, no. 1 (1 July 2016): 12, https://doi.org/10.1162/ISEC_a_00249. [XYZ add Van Hooft 2020 here ;)

179 Hodges, Horrel, and Kuz, 'Russia's Militarization of the Black Sea'.

Ukraine used these advantages to target Russian vessels with long-range artillery, anti-tank missiles, and anti-ship missiles. In this first phase of the war, Ukraine carried out attacks from ashore to severely damage the Russian Black Sea Fleet, imposing a 100-nautical-mile buffer in the north-western part of the Black Sea.[180] In a series of attacks, Ukrainian forces hit a Russian *Raptor* assault boat near Mariupol with an anti-tank missile, sunk the Russian tugboat *Vasily Bekh* with two *Harpoon* missiles, and destroyed landing ship *Saratov* moored in Berdyansk using a Soviet-era *Tochka* tactical ballistic missile.[181] Russia also lost two *Raptor*-class patrol boats and a *Serna*-class landing craft due to Ukrainian attacks with *Bayraktar* TB2 UAVs.[182]

Most famously, Ukraine sunk the Russian Black Sea Fleet (BSF) flagship *Moskva*. The ship was reportedly sunk by two Ukrainian-developed *Neptune* anti-ship missiles launched from ashore, that snuck past the ship's defences while its main fire-control radar was distracted by a Ukrainian TB2 UAV operating in the vicinity.[183] While Ukraine demonstrated its prowess in coordinating UAVs and missiles, the success of the attack also depended upon Russian shortcomings, such as the radar having been stowed at the moment of the attack and the failure to contain the fire generated by the missiles.[184] Additionally, a newer ship equipped with "better air defences and a sharper crew might have parried the Ukrainian missiles."[185] The sinking of the Moskva was particularly significant, as the ship carried out important command and control tasks and its sinking granted Ukrainian UAVs more freedom to operate.[186] A similar tactic (a combination of UAVs with anti-ship missiles launched from ashore) was also instrumental in Ukraine's success in recapturing Snake Island in June 2022. Combined attacks from drones and anti-ship missiles damaged the Russian vessels transporting S-400 SAM systems and EW equipment, preventing the installation of these key capabilities on the rock formations. The proximity of Snake Island to the Ukrainian coastline made it easily reachable by ground-based and drone strikes. It proved to be a logistical nightmare for Russia to defend because vessels approaching the island were easily detected and the considerable distance from Russia's main naval bases in the Black Sea.[187]

Both Russia and Ukraine targeted the other's military forces through the deployment of naval mines along Ukraine's southern coast. Different types of mines were used, contact mines and magnet mines, as well as modifications of those with vibro-sensors. Russia reportedly laid up to 600 mines and Ukraine around 370. This made movement in the Black Sea risky for merchant and military vessels, especially because minesweepers are easy targets.[188]

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180 'How Did Ukraine Destroy the Moskva, a Large Russian Warship?', *The Economist*, accessed 5 March 2024, https://www.economist.com/the-economist-explains/2022/04/20/how-did-ukraine-destroy-the-moskva-a-large-russian-warship.

181 Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO', 196.

182 Seth G. Jones, 'Russia's Ill-Fated Invasion of Ukraine: Lessons in Modern Warfare', CSIS Briefs (Centre for Strategic and International Studies, June 2022), 7, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220601_Jones_Russia%27s_Ill-Fated_Invasion_0.pdf?VersionId=Ggqjb.JsRbJzr_wlu5jrVT_Xe3AW3jur.

183 Bommakanti, 'The Military Lessons of the Russia-Ukraine War', 15.

184 Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022', 45.

185 'How Oceans Became New Technological Battlefields', *The Economist*, July 2023, https://www.economist.com/special-report/2023/07/03/how-oceans-became-new-technological-battlefields.

186 Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO', 196.

187 Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO'; 'Snake Island: Why Russia Couldn't Hold on to Strategic Black Sea Outcrop', *BBC News*, 30 June 2022, sec. Europe, https://www.bbc.com/news/world-europe-61992491.

188 Lorenzo Tondo, 'Sea Mines: The Deadly Danger Lurking in Ukraine's Waters', *The Guardian*, 11 July 2022, sec. World news, https://www.theguardian.com/world/2022/jul/11/sea-mines-ukraine-waters-russia-war-black-sea.

Moreover, drifting mines became a dangerous side effect of the heavily mined Black Sea.[189] Sea mines were also a major factor in deterring Russia from attempting an amphibious landing.[190] Despite forming two amphibious detachments of three large amphibious ships in the months before the war, Russia ultimately decided not to commit its maritime assault units and refrained from launching amphibious assaults between Mykolaiv and Odesa. This came after an initial reconnaissance landing by Russian special forces in the first days of the invasion that resulted in the destruction of many raiding craft and heavy casualties.[191]

Sea denial proved a real challenge both to the offender and the defender.

By the end of the initial phase of the war, a situation of sea denial as a key feature of the war at sea, that would endure until the time of writing, had emerged. Sea denial proved a real challenge both to the offender and the defender. Ukraine's use of long-range artillery, anti-tank missiles, anti-ship missiles, mines, and drones all combined to deny Russia effective access to the Black Sea both to support ground operations with naval fires and to conduct amphibious landings.

At the same time, Russia succeeded in denying Ukraine's ability to conduct international maritime trade by instituting a naval blockade in ports in both the Black Sea and the Sea of Azov (Figure 7). As soon as hostilities broke out, Russia imposed a blockade on the harbours of Pivdennyi, Mykolaiv, Olviia, Odesa, Chornomorsk, and Bilhorod-Dnistrovskyi, which before the war accounted for almost 90% of Kyiv's total maritime trade.[192] Blockading these ports was a strategic choice for Russia, which effectively managed to shrink Ukrainian trade revenue in this first phase of the war before the Black Sea Grain Initiative was brokered by the United Nations in the summer of 2022.[193] The blockades prevented Ukraine from exporting its major source of revenue, agricultural products, making up 41% of the country's total exports in 2021. As Ukrainian exports account for "10% of the world wheat market, 15% of the corn market, 13% of the barley market, and 50% of the sunflower oil market," Russia's naval blockade had a global effect, fuelling inflation and food insecurity worldwide.[194] For Ukraine, it resulted in a considerable loss of income, creating serious difficulties in resourcing its war effort.[195] Thus, while being challenged by Ukraine's attacks on its vessels, Russia adapted its tactics to strangle Ukraine economically via a series of naval blockades.

189 'Risk of Collateral Damage in the North Western, Western, and Southwest Black Sea', NATO Allied Maritime Command, 28 February 2023, https://shipping.nato.int/nsc/operations/news/-2022/risk-of-collateral-damage-in-the-north-western-black-sea-2.aspx.

190 Savitz and Courtney, 'The Black Sea and the Changing Face of Naval Warfare'.

191 Zabrodskyi et al., 'Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022', 30.

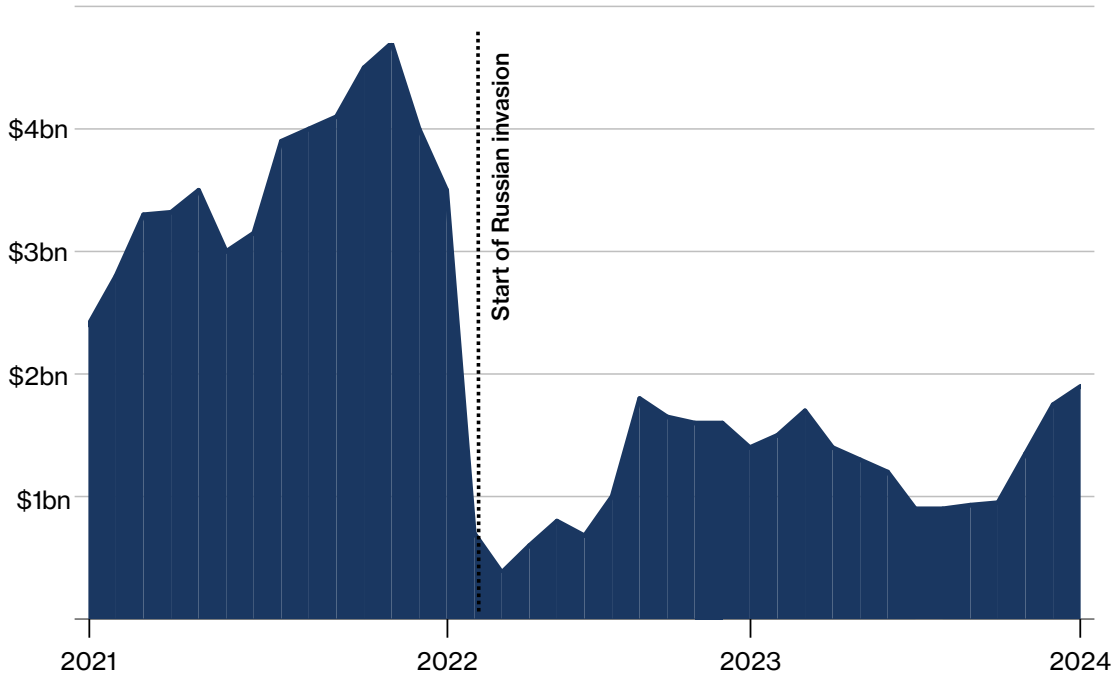
192 Alessio Patalano, 'The Maritime War in Ukraine The Limits of Russian Sea Control?' (The Hague Centre For Strategic Studies, December 2024).

193 Raul (Pete) Pedrozo, 'Russia-Ukraine War at Sea: Naval Blockades, Visit and Search, and Targeting War-Sustaining Objects', *Lieber Institute West Point* (blog), 25 August 2023, https://lieber.westpoint.edu/russia-ukraine-war-naval-blockades-visit-search-targeting-war-sustaining-objects/.

194 Oleksiy Goncharenko, 'Russia's Black Sea Blockade Is Part of Putin's War on International Law', *Atlantic Council* (blog), 22 March 2023, https://www.atlanticcouncil.org/blogs/ukrainealert/russias-black-sea-blockade-is-part-of-putins-war-on-international-law/.

195 Patalano, 'The Maritime War in Ukraine The Limits of Russian Sea Control?'

Figure 7. Maritime exports from Ukraine between 2021 and 2024



Source: Financial Times

5.2. **Consolidated defence** (August 2022 – February 2023)

The situation of sea denial persisted in the second phase of the war. Ukraine further degraded the effectiveness of the Russian Black Sea fleet. In August 2022, Ukraine attacked the Saky airbase, successfully destroying half of the aircraft of the fleet's aviation regiment. In the same month, Ukraine also hit the Naval Headquarters in Sevastopol. Sevastopol was further targeted by Ukraine in October 2022, when a large raid on the naval base severely damaged a Russian frigate (the *Admiral Makarov*) at sea and a mine countermeasures vessel.[196] While Ukraine continued using tactics seen in the first phase of the war (unmanned vehicles + land-based missile strikes + sea mines), a few novel elements emerged in this second phase. These were, in particular, the increased and consistent use of unmanned vehicles, especially explosive-laden USVs, which were used to target Russian naval bases and stationary units.

Ukraine's use of explosive-laden USVs proved effective due to several factors. First, USVs are relatively low-cost and mostly indigenously produced. Ukraine could hence deploy large numbers of USVs, equipped with electro-optical and infrared sensors and Starlink antennae, and powered in part by commercial off-the-shelf technology. Low costs also mean that they are produced in large quantities, allowing for higher expendability on the battlefield.[197]

196 Osinga, 'Putin's War, a European Tragedy: Why Russia's War Failed and What It Means for NATO', 196.

197 Sidharth Kaushal, 'Ukraine's Uncrewed Raid on Sevastopol and the Future of War at Sea', RUSI, 2 February 2023, https://rusi.orghttps://rusi.org.

Additionally, USVs strike at the waterline, damaging ships' critical components such as engines and munition storage, potentially causing secondary explosions, and producing gashes that cause flooding. They can also carry a larger payload than UAVs, mines, and torpedoes, enabling strikes of larger magnitude.[198] Most importantly, Ukraine focused on targets stationed in littoral waters. In fact, USVs are likely to be less effective in 'blue waters,' where they can be more easily detected and are limited by their endurance.[199] Lastly, while the employment of unmanned systems as 'suicide craft' is not new, Ukraine has shown significant skill in coordinating the attacks of USVs, not only amongst themselves but also in combination with UAVs and missiles, as in the larger scale raid on Sevastopol in October 2022.[200]

As highlighted above, most Ukrainian major hits on Russian naval assets in the second phase of the war were carried out through attacks on naval bases. Ships docked in naval bases and ports provide stationary targets against simple backgrounds. Detection and targeting of such assets became easier for Ukraine, especially coupled with the intel provided by foreign powers including the US and UK, which provided fused data from satellites and surveillance aircraft.[201] This vulnerability of the Black Sea fleet to combined drone and missile raids led to the relocation of most Russian naval assets to the Russian port city of Novorossiysk, which itself would be subject to Ukrainian attacks in later phases.

During this second phase, Ukraine continued to deny the Russian navy the ability to use the Black Sea fleet effectively, eventually pushing the fleet to relocate away from its long-standing headquarters in occupied Crimea. The continued combination of missiles, UAVs, and USVs against vulnerable surface targets degraded the Russian fleet and continued to render capital ships ineffective. Importantly, this denial has come at relatively low cost, with 'suicide' USVs being indigenously produced at scale with relatively minimal resource expenditure. Finally, by focusing on littoral defence, Ukraine not only degraded the Black Sea fleet but also ensured Russian assets would be less effective in the support of ground operations and could not be used in amphibious assaults to open a new front.

Given that the rest of the Black Sea is bounded by NATO allies Romania, Bulgaria, and Türkiye (which due to the Montreux Convention decides which ships can come and go from the Black Sea), the Russians became effectively trapped in the sea in this phase. Such political level factors would continue to have important operational consequences throughout the war.

5.3. **Counterattack** (March 2023 – September 2023)

The third phase of the war saw Ukraine continuing its successful sea denial operations by carrying out attacks combining missiles, UAVs, and USVs. The main differences with the prior phases of the war were the use of USVs in much larger quantities alongside the use of foreign-provided cruise missiles and the targeting of logistics and repair facilities.

198 Savitz, 'The Age of Uncrewed Surface Vessels'.

199 Kaushal, 'Ukraine's Uncrewed Raid on Sevastopol and the Future of War at Sea'.

200 Nick Childs, 'Ukraine: Unconventional Impact at Sea?', IISS, 11 November 2022, https://www.iiss.org/online-analysis/military-balance/2022/11/ukraine-unconventional-impact-at-sea/.

201 'How Oceans Became New Technological Battlefields'.

During the autumn 2023 counteroffensive, Ukraine further damaged the Black Sea fleet, delivering its most effective hits through a combination of USVs, UAVs and missile attacks. In August 2023, the Russian *Ropucha*-class landing ship *Olenegorskiy Gornyak* was severely damaged at sea by a USV attack, with the vehicles travelling over 800 kilometres to deliver the hit near Novorossiysk.[202] In September, Ukraine again targeted Sevastopol, critically damaging the large landing ship *Minsk* and one of the six *Kilo*-class submarines, the *Rostov-on-Don,* both of which were stationed in drydock. Damaging the *Rostov-on-Don* was of particular significance, as this was one of the submarines Russian forces had used to launch attacks on Ukrainian civilian and military targets by means of its *Kalibr* cruise missiles. Since anti-submarine warfare is particularly challenging, and especially for forces with underdeveloped naval capabilities such as Ukraine, significantly damaging a submarine while in drydock represented a significant achievement.[203]

These successful raids were carried out primarily by combinations of large numbers of USVs and UAVs and land-based missiles, with tactics that had already been employed in the earlier phases, as explored above. However, in the third phase of the war, Ukraine further developed its USVs capabilities, augmenting both the indigenous production of these vehicles and their endurance. This allowed for the use of USVs in higher numbers and enabled the Ukrainians to target over longer distances. Additionally, Ukraine had initially relied mainly on indigenously produced missiles (e.g. *Neptune*) or Soviet legacy systems (e.g. *Tochka*) for its strikes against the Russian navy. The August and September 2023 attacks were however carried out with Anglo-French *Storm Shadow/SCALP EG* missiles. These air-launched cruise missiles have longer ranges than Ukrainian-produced missiles, making Russian positions previously considered safe suddenly vulnerable.[204] In an attempt to protect its warships from such attacks, Russia repainted some of its ships to hide the overall length and form of the ship when viewed from the surface and from above and thus from USVs and UAVs.[205]

In addition to targeting vessels of the Black Sea fleet, Ukraine also focused on disrupting Russia's ability to repair and resupply its naval capabilities. In July, a USV attack targeted the Kerch Strait bridge, damaging both spans, a primary supply route for Russia and a major symbolic target, as it links the Crimean Peninsula to Russia.[206] The September attack on Sevastopol also damaged a major shipyard with a dry dock that is essential for repairing decades-old Russian ships. The extensive damages to the port facilities complicated Russia's ability to maintain its fleet and forced many vessels to head to Novorossiysk for repairs.[207] Ukraine also successfully hit the Russian oil tanker *Sig* as well as civilian vessel *Sparta IV*,

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202 Borja Lasheras, 'Black Sea Successes and Ukraine's Path to Victory', CEPA, 5 February 2024, https://cepa.org/article/black-sea-successes-and-ukraines-path-to-victory/.

203 Steven Wills, 'Sea Control in the Black Sea Still up for Grabs', Center for Maritime Strategy, 3 October 2023, https://centerformaritimestrategy.org/publications/sea-control-in-the-black-sea-still-up-for-grabs/; Oleksiy Goncharenko, '2023 Review: Ukraine Scores Key Victories in the Battle of the Black Sea', *Atlantic Council* (blog), 5 December 2023, https://www.atlanticcouncil.org/blogs/ukrainealert/2023-review-ukraine-scores-key-victories-in-the-battle-of-the-black-sea/.

204 Wills, 'Sea Control in the Black Sea Still up for Grabs'; Ben Farmer, Roland Oliphant, and Connor James Ibbetson, 'How British Storm Shadow Missiles Are Defining a New Phase in Ukraine's War', *The Telegraph*, 4 October 2023, https://www.telegraph.co.uk/world-news/storm-shadow-cruise-missile-ukraine-war-cost-how-used-uk/.

205 H. I. Sutton, 'New Technology Sees Through Russian Attempt to Hide Ships from Ukraine', *Naval News* (blog), 12 July 2023, https://www.navalnews.com/naval-news/2023/07/new-technology-sees-through-russian-attempt-to-hide-ships-from-ukraine/.

206 Carlotta Gall and Oleksandr Chubko, 'Inside the Commando Raids Unnerving Russia in Crimea', *The New York Times*, 22 October 2023, sec. World, https://www.nytimes.com/2023/10/22/world/europe/ukraine-commandos-russia-crimea.html.

207 Tom Balmforth, 'Ukraine Says Russian Naval Vessels Badly Damaged in Crimea Attack', *Reuters*, 13 September 2023, sec. Europe, https://www.reuters.com/world/europe/ukraine-launches-missile-attack-sevastopol-crimea-russian-installed-governor-2023-09-13/.

which was used to supply military equipment to Russian forces, circumventing Türkiye's closing of the Bosporus Strait to military vessels.[208] While this did not decisively tip the balance, it helped disrupt Russian logistics by slowing down the provision of fuel, artillery, and other types of equipment to the units engaged in land operations.

Alongside missile and USV/UAV attacks, Ukraine also started a series of commando raids in July 2023. These raids by special operations forces targeted primarily Russian EW capabilities. In August, commandos attacked a Russian base at Cape Tarkhankut, in western Crimea, targeting an antenna and systems that jam electronic communications over a wide area.[209] These raids were conducted by Ukrainian commandos moving over the sea surface with small boats and jet skis, exhibiting considerable creativity in deploying unconventional capabilities.

This period featured many of the previous trends with ground-based standoff capabilities deployed against naval assets, further amplified by the delivery of foreign-supplied missile systems. Continuous replenishment of stockpiles of missiles and drones of all types was instrumental in keeping pressure on both sides' forces.

5.4. **Stalemate** (October 2023 – November 2024)

In the most recent phase of the war, Ukraine has continued to deny Russia access to its coastline. By this fourth phase, Ukraine's attacks "have diminished the BSF's [Black Sea Fleet] ability to conduct wide security patrols, carry out routine maintenance, and enforce blockades of Ukrainian ports in the western Black Sea." [210] This continuous denial helped maintain a stalemate at sea in Ukraine's favour, as Russian control over the Black Sea would have allowed greater pressure on land forces and possibly allowed for the opening of a new front far behind the Ukrainian front lines.

In October 2023, almost all of the remaining Black Sea fleet was moved from Sevastopol in western Crimea to Novorossiysk in Russia's Krasnodar Krai region to the east.[211] While this move did not drastically change the course of the war at sea (Russian warships continued firing cruise missiles on Ukrainian territory), it signalled the effectiveness of Ukraine's earlier attacks in downgrading Sevastopol's ability to operate as a combined arms headquarters and to support logistical routes in southern Ukraine.[212] Ukraine in fact succeeded in diminishing Russia's ability to bombard Ukraine using the fleet's missile-carrying warships

208 Tim Lister Nechyporenko Victoria Butenko,Kostan, 'Ukraine Hits Russian Oil Tanker with Sea Drone Hours after Attacking Naval Base', CNN, 5 August 2023, https://www.cnn.com/2023/08/05/europe/ukraine-sea-drone-attacks-intl/index.html; Alexander Palmer et al., 'A Wolf in Ship's Clothing: Russia's Militarization of Civilian Vessels in the Black Sea', 24 August 2023, https://www.csis.org/analysis/wolf-ships-clothing-russias-militarization-civilian-vessels-black-sea.

209 Gall and Chubko, 'Inside the Commando Raids Unnerving Russia in Crimea'.

210 'Ukrainian Strikes Have Changed Russian Naval Operations in the Black Sea', Institute for the Study of War, 16 December 2023, http://dev-isw.bivings.com/.

211 Peter Dickinson, 'Putin's Fleet Retreats: Ukraine Is Winning the Battle of the Black Sea', Atlantic Council, 4 October 2023, https://www.atlanticcouncil.org/blogs/ukrainealert/putins-fleet-retreats-ukraine-is-winning-the-battle-of-the-black-sea/.

212 'Ukrainian Strikes Have Changed Russian Naval Operations in the Black Sea'.

and disrupting the logistics and supply chains of the Russian armed forces in Crimea and southern Ukraine.[213]

Even after the Russian retreat, Ukraine continued its combined attacks. Ukraine managed to damage a recently constructed Russian naval corvette *Askold* near the Zalyv shipyard in Kerch, Crimea.[214] Ukrainian USV attacks also hit two Russian assault boats (crewed and with armoured vehicles) near Chernomorskoe, Crimea. Both the base of the Black Sea Fleet and the Federal Security Service were also targeted during the attack.[215] *Ropucha*-class landing ship *Novocherkassk* was damaged in an overnight Ukrainian attack on the Crimean port city of Feodosia in October, as Kyiv suspected the ship was transporting Iranian-made explosive drones.[216] The month thereafter, in November 2023, the missile-carrying corvette *Ivanovets* was struck by satellite-controlled USVs, and subsequently sunk stern-first.[217] In February 2024, Ukrainian forces attacked the *Tsesar Kunikov*, a 112-meter (367-foot) Russian warship, with a Ukrainian-designed USV packed with explosives (the Magura V5), sinking it off the Crimean coast, near the resort town of Alushka.[218] Lastly, Ukrainian forces attacked the $65 million Russian warship *Sergei Kotov* with Magura V5 naval kamikaze drones. On impact, the ship exploded and sank.[219]

The *Ivanovets* attack, in particular, offers interesting insights into Ukrainian USV tactics. The corvette had both defensive weapon systems and high speed and manoeuvrability. The vessel attempted several defensive operations, including increasing speed, performing evasive manoeuvres, and engaging the USVs with the AK-630 rapid-fire batteries, to no avail. In this attack, Ukraine used packs of six to ten USVs.[220] The USVs "execute[d] manoeuvres like Simultaneous Time On Target (STOT), suggesting low autonomy support, remote-controlled manoeuvres, and the application of a 'swarm' tactic with approaches from different sectors and sequential attacks."[221] The tactic behind the attack seemed to first achieve impact on the target ship, slowing down its speed to carry out subsequent attacks in order to sink it.

Additionally, in each of the cases of corvette *Ivanovets*, tank-landing ship *Tsesar Kunikov*, and missile patrol ship *Sergey Kotov*, Russian ships were operating alone and unsupported by

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213 Peter Dickinson, 'Ukraine's Black Sea Success Offers Hope as Russian Invasion Enters Third Year', *Atlantic Council* (blog), 15 February 2024, https://www.atlanticcouncil.org/blogs/ukrainealert/ukraines-black-sea-success-offers-hope-as-russian-invasion-enters-third-year/.

214 Kateryna Danishevska, 'Strike on Corvette Askold in Crimea: British Intelligence Assesses Consequences for Russia', accessed 5 March 2024, https://www.msn.com/en-us/news/world/strike-on-corvette-askold-in-crimea-british-intelligence-assesses-consequences-for-russia/ar-AA1jwlYJ.

215 Adam Renton, 'Ukraine Claims It Hit Two Russian Landing Craft in Crimea with Sea Drones', CNN, 10 November 2023, https://www.cnn.com/2023/11/10/europe/ukraine-occupied-crimea-sea-drone-attack-intl/index.html.

216 'Russia Confirms Ukraine Destroyed Its Warship in Crimea Attack | Russia-Ukraine War News | Al Jazeera', accessed 5 March 2024, https://www.aljazeera.com/news/2023/12/26/ukraine-claims-to-have-destroyed-russian-ship-in-crimea-attack.

217 Robert Greenall, 'Ukraine "Hits Russian Missile Boat Ivanovets in Black Sea"', *BBC News*, 1 February 2024, sec. Europe, https://www.bbc.com/news/world-europe-68165523.

218 'Russian Landing Ship Caesar Kunikov Sunk off Crimea, Says Ukraine', 14 February 2024, https://www.bbc.com/news/world-europe-68292602.

219 Luke Harding, 'Ukraine Claims to Have Sunk Russian Warship in Occupied Crimea', *The Guardian*, 5 March 2024, sec. World news, https://www.theguardian.com/world/2024/mar/05/ukraine-russian-warship-occupied-crimea-sinking.

220 Hasan Özyurt, 'Analysis: An Operational View on the USV Attacks in the Black Sea from an Admiral's Eyes', *Naval News* (blog), 18 February 2024, https://www.navalnews.com/naval-news/2024/02/analysis-an-operational-view-on-the-usv-attacks-in-the-black-sea-from-an-admirals-eyes/.

221 Özyurt.

other units. This made them easier targets for groups of Ukrainian USVs.[222] Missile strikes continued against targets in port as well throughout the course of 2024, where in the summer of 2024, the *Rostov-on-Don* submarine was again struck while at anchor in Sevastopol, this time sinking the vessel.[223] Since this sinking, the Black Sea fleet has remained stuck, with movement, maintenance, and resupply occurring under the constant danger of Ukrainian missile and drone strikes, with repositioning or relief unlikely given Türkiye's control of the Bosphorus under the Montreux convention.[224]

This latest phase of the war continued to feature the dynamics of the previous phases including sea denial by the use of missiles, drones, and sea raids. This situation of persistent denial has played an important role in Ukraine's overall defence by ensuring that Russia's naval operations cannot be used to adequately support ground manoeuvres nor to open up a new front via amphibious landing. While setbacks have been felt on land, the Ukrainian armed forces froze the lines at sea early and have continued to do so for nearly three years as of writing.

222 Steven Wills, 'Sea Drone Swarms – Can NATO's Navies Avoid Russia's Fate?', CEPA, 6 March 2024, https://cepa.org/article/sea-drone-swarms-can-nato-navies-avoid-russias-fate/.

223 John Grady, 'Russian Attack Submarine Sunk in Missile Strike on Black Sea Port Claims Ukraine', US Naval Insitute News, 4 August 2024, https://news.usni.org/2024/08/04/russian-attack-submarine-sunk-in-missile-strike-on-black-sea-port-claims-ukraine.

224 Ellie Cook, 'Russia's Black Sea Fleet "Sitting Ducks" as Ukraine Sinks Submarine', Newsweek, 7 August 2024, https://www.newsweek.com/russia-black-sea-fleet-crimea-submarines-rostov-don-ukraine-turkey-1935266.

6. Insights for a Contingency over Taiwan

Are the observations from the Russian invasion of Ukraine applicable to a potential Chinese invasion of Taiwan? Certainly, there are clear and considerable differences between Ukraine and Taiwan, as discussed in the introduction to this study. There is a risk of overlearning from the Russian war against Ukraine as it applies to Taiwan or indeed any other conflict. The course of any war is shaped by a great range of tangible and intangible factors including the balance of capabilities between the belligerents (based not just on the quality and quantity of platforms, but also on the readiness of their forces, unit cohesion, and morale), military strategy, battlefield conditions as dictated by particular geographies, international support, and of course, the inevitable "friction" that comes about when two opponents clash in battle. Moreover, the PRC's decision to embark on an invasion of Taiwan will ultimately be rooted in political considerations rather than solely military ones.[225]

Yet the ongoing war offers plenty of relevant lessons for a potential contingency over Taiwan if only for the reason that the CCP and the PLA are watching the ongoing war as well and drawing their own lessons. The PLA has been particularly attentive to the ways in which Ukrainian operations could be similar to US or Taiwanese tactics or approaches.[226] This chapter identifies insights for C4ISR, the land, sea, and air domains, and, finally, outlines some more general lessons.

6.1. C4ISR

Joint operational command has long been a concern for the PLA, and a priority for Xi himself in terms of the PLA's military reform. The inability of Russia to achieve a rapid *fait accompli* alongside a massive hybrid operation, cyber-attacks, and missile strikes to disrupt Ukraine's defences, will likely give PLA planners pause as they look at scenarios to invade Taiwan. Beijing has certainly taken note that Moscow's expectation of a short war was unfounded.[227] Recently, the PRC has undertaken a major reform by dissolving the PLA Strategic Support Force and establishing the separate Information Support Force, Aerospace Force, and

225 Emma Ashford et al., 'Testing Assumptions About the War in Ukraine, One Year Later', Stimson Center, 15 February 2023.

226 Evan A. Feigenbaum and Charles Hooper, 'What the Chinese Army Is Learning From Russia's Ukraine War', Carnegie Endowment, Carnegie Endowment for International Peace, 21 July 2022, https://carnegieendowment.org/posts/2022/07/what-the-chinese-army-is-learning-from-russias-ukraine-war?lang=en.

227 Taylor Fravel, 'China's Potential Lessons from Ukraine for Conflict over Taiwan', *The Washington Quarterly* 46, no. 3 (3 July 2023): 7–25, https://doi.org/10.1080/0163660X.2023.2260141.

Cyberspace Force.[228] This is in line with Xi's call to strengthen 'combat effectiveness' (新质战斗力), and reflects Beijing's realisation that achieving effective joint operations requires better command and control mechanisms as well as greater attention to the fundamentals of military leadership. [229]

In addition, the differences in geography between Ukraine and Taiwan generate meaningful differences for the role of C4ISR. Ukraine is made up of 603,628 km², with a significant amount of flat, rural territory in the most contested regions of the country. The island of Taiwan sits at 36,197 km², including the outlying islands and is heavily urbanised. It is therefore much simpler for the PLA to obtain a 360-degree picture of Taiwan than it is for Russia to obtain one of Ukraine. However, given how mountainous Taiwan is, especially through the Central Mountain Range, it is much more difficult for airborne ISR to collect possible targets.

Command failures, faulty communications, and poor intelligence can hamstring a campaign from its first moments and augur in defeat.

At a higher level, Russia suffered in its early phases from discordance in both its command and intelligence structures, a limitation Ukraine did not share. Ukraine also benefited from nearly a decade of direct covert support from Western intelligence agencies to improve its indicators and warning system. Given the unique focus of the PLA on Taiwan to include dedicated civilian and military units across services, joint staffs, and civilian agencies, it is perhaps less likely, although not impossible, that the PRC will suffer from the same intelligence failures Moscow did in early 2022.

There is of course a margin of uncertainty to each of these observations, given how highly secretive C4ISR activity is, even more so in the case of the PRC. This section draws much upon translated sources from American and Taiwanese experts on the PLA.

6.1.1. Lessons and Implications

Across the three levels of command, communications, and intelligence, there are a number of takeaways from the ongoing Russo-Ukrainian war that are relevant for Taiwan. They range from higher-order, structural deficiencies to implications for force design and capability investments. In short, the first and most relevant lesson for C4ISR for any state is that dysfunction across the elements of one's own C4ISR can be catastrophic. Command failures, faulty communications, and poor intelligence can hamstring a campaign from its first moments and augur in defeat. The second most relevant overall lesson is that despite these failures armed forces can adapt surprisingly well to rectify them and advantages built up by the adversary can be lost or degraded over time. Both main lessons indicate that C4ISR merits continuous attention across its aspects.

6.1.2. Command

Taiwanese military planners will need to work under the assumption that China will attempt to cut command and control at almost every level and will be successful in some areas at

228 Eric Chan, 'The Adaptation Battle: The PLA and Lessons from the Russia-Ukraine War', *Global Taiwan Brief* 8, no. 13 (28 June 2023), https://globaltaiwan.org/2023/06/the-adaptation-battle-the-pla-and-lessons-from-the-russia-ukraine-war/.

229 Ying Yu Lin and Tzu-Hao Liao, 'RIP, SSF: Unpacking the PLA's Latest Restructuring', The Diplomat, 23 April 2024, https://thediplomat.com/2024/04/rip-ssf-unpacking-the-plas-latest-restructuring/.

doing so.[230] Starting at the highest level, clarity of responsibilities and sufficient trust between civilian authorities and the Chief of the General Staff is critical. In the last moments prior to an attack and in the earliest phases of an assault, this relationship is vital in ensuring the transfer of authority and the adequate coordination of military activities, civil defence, and government continuity. This is not so much about costly capabilities but about people and preparation, including at the very top echelons of government. History is replete with examples of states falling to *fait accompli* attacks due to civil-military strife in the capital, from the fall of Paris in 1940 to the surrender of Saigon in 1975.[231] This relationship requires investment in time and resources, to include joint civil-military exercises of island defence.

Below the civil-military apex sits the inter-service relationships between the ground, maritime, and air services of the armed forces. Command relationships between these three services, and within them the various regional command structures, are central to ensuring effective joint operations throughout the duration of a conflict. The Russian ground and air forces clearly suffered from this issue as Russian forces were unable to effectively coordinate action in both domains. For Taiwan, particularly with the current national doctrine of 'multi-domain [or comprehensive] deterrence' (多域威慑), ensuring effective coordination of key activities like precision strike, air and missile defence, anti-ship missile targeting, and countering amphibious forces requires a significant amount of coordination. Clarity of command responsibilities in given regions requires adherence to the principle of unity of command (統一指揮原則).[232] Achieving this unity in practice is much harder than in principle, given that it places by default one commander over another. The alternative, however, is to have at best delayed decision-making and at worst active competition between different commanders. This necessitates practice as much as reform, with training and exercising across services necessary to turn joint operations into a reality.

An additional principle for command is the concept of mission command or the combination of a commander's centralised intent with decentralised execution by empowered subordinates. For maritime and air forces, naval command principles and the speed of air combat create a mission command environment almost by default. For ground forces, it is particularly challenging due to more hierarchical command structures, and arguably, most Western forces are unable to achieve this themselves. However, a Taiwanese demonstration of mission command and the ability to synchronise regular army, reserve, and territorial defence combat power would vastly complicate PLA targeting and contribute to early and sustainable successes. By practising effective mission command, Taiwan can demonstrate resistance to decapitation/paralysis-style strikes and enhance its own ability to strike at PLA targets in the littoral or on shore, wherever they may be most vulnerable.

6.1.3. **Communications**

For Taiwan, the situation is very different from Ukraine when it comes to the reliability of military and/or government communications in the event of a conflict. China is much better positioned to impose a near-complete digital isolation of the island. Most of Taiwan's on-island

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230 Eric Chan, 'Lessons for Taiwan from the Russia-Ukraine War, Part 2: The Importance of Airpower and Initiative', Global Taiwan Institute, 20 April 2022, https://globaltaiwan.org/2022/04/lessons-for-taiwan-from-the-russia-ukraine-war-part-2-the-importance-of-airpower-and-initiative/.

231 Vipin Narang and Caitlin Talmadge, 'Civil-Military Pathologies and Defeat in War: Tests Using New Data', *The Journal of Conflict Resolution* 62, no. 7 (2018): 1379–1405; William L. Shirer, *The Collapse of the Third Republic: An Inquiry into the Fall of France in 1940* (New York: Simon and Schuster, 1969).

232 I B. Stares, *Command Performance: The Neglected Dimension of European Security* (Washington, D.C.: The Brookings Institution, 1991).

digital communications architecture is concentrated in the northern portion of the island, well within range of China's substantial inventory of short-range ballistic missiles and certainly vulnerable to cyberattacks. This architecture includes the most critical submarine cable landing stations, which route international internet traffic to and from the island, along with a handful of data centres.[233] Furthermore, Taiwan cannot depend on SpaceX's Starlink, as it is not yet available in the country, and CEO Elon Musk is likely to be more vulnerable to coercion from Beijing due to significant business interests in China.[234]

Taipei's ongoing efforts to harden its communications and digital infrastructure are crucial. Establishing eleven non-geostationary orbit satellite hotspots and five links for cellular satellite backhauls, as currently envisaged under Taiwan's Telecom Technology Centre's plans, will be an important step towards ensuring more stable coverage in the event of a crisis or invasion.[235] Still, off-island solutions may need to be available as well. Ukraine benefited from the support of Microsoft which now hosts most of Kyiv's critical government services on servers based in neighbouring Poland. Ensuring secure and accessible military and government functions through foreign-supported cloud services will likely be necessary, and several Taipei-friendly governments would be amenable to such an arrangement. On military communications specifically, Taiwan is already strengthening its connectivity with the US in particular, reportedly by adopting NATO's Link-22 tactical data link (TDL) system.[236]

6.1.4. **Intelligence**

On the intelligence front, Taipei actually has advantages that neither Ukraine nor its Western backers had in relation to China. Taipei's persistent intelligence effort centred on indicators and warnings of a possible Chinese attack keeps the Taiwanese intelligence community focused. Indeed, Taiwan's Military Intelligence Bureau (MIB) and National Security Bureau (NSB) are likely better placed than US intelligence to make such predictions and identify PLA manoeuvres, given recent US difficulties in collection against Beijing.[237] Put simply by one anonymous Western intelligence official, "We really don't know how the (Chinese) politburo think."[238] Taipei is arguably in a much better position to have significant HUMINT, SIGINT, and ELINT that can be fused to make a more accurate assessment of Chinese intentions and capabilities. Such intelligence, more sensitively, also extends to the presence of foreign agents on Taiwanese soil. Ukraine was able to nullify the effects of Russian collaborators and defectors shifting sides during the invasion and prevent them from leading to a lapse in Ukrainian defences.

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233 Jason Vogt, Nina Kollars, and Michael Poznansky, 'Should Taiwan Attempt to Replicate the Zelensky Playbook?', War on the Rocks, 15 May 2024, https://warontherocks.com/2024/05/should-taiwan-attempt-to-replicate-the-zelensky-playbook/.

234 Eric Chan, 'The Adaptation Battle: The PLA and Lessons from the Russia-Ukraine War', Global Taiwan Brief (Washington, D.C.: Global Taiwan Institute, 28 June 2023), 7, https://globaltaiwan.org/wp-content/uploads/2023/06/GTB-8.13-PDF.pdf.

235 Lawrence Chung, 'Taiwan Ramps up Backup Satellite Network Plans in Island Defence Strategy', South China Morning Post, 7 October 2023, https://www.scmp.com/news/china/military/article/3237034/taiwan-ramps-backup-satellite-network-plans-island-defence-strategy.

236 Matthew Strong, 'Taiwan to Receive NATO's Link 22 Radio System from US', Taiwan News, 25 May 2023, https://taiwannews.com.tw/en/news/4901820.

237 Julian E. Barnes and Adam Goldman, 'Captured, Killed or Compromised: C.I.A. Admits to Losing Dozens of Informants', *The New York Times*, 5 October 2021, sec. U.S., https://www.nytimes.com/2021/10/05/us/politics/cia-informants-killed-captured.html.

238 Gordon Corera, 'China's Spy Threat Is Growing, but the West Has Struggled to Keep Up', BBC, 15 May 2024, https://www.bbc.com/news/articles/cmm33rm32veo; Jon Wolfsthal, 'What Did the DOD Know About Chinese Missiles in the Latest PRC Nuclear Capabilities Report?', Federation of American Scientists, 1 October 2024, https://fas.org/publication/dod-prc-silos-water-know/.

Even with the best intelligence collection efforts, there can still be failures. A particular source of such failures is the existence of walls between military and civilian intelligence services, which can lead to conflicting information reaching senior civilian leaders and military commanders, risking either inaction or overreaction. Such issues have apparently been present between the MIB and NSB in the past, leading to interagency tensions.[239] Reportedly there is an ongoing reform effort of Taiwan's intelligence community, though detail will of course remain limited for some time.[240] The main principles of such an effort should be to ensure information can flow smoothly across intelligence services and that rigorous analytical discussions are held to test and falsify theories about Beijing's intentions in a crisis.

On a very basic asset level, the importance of drones to ensure effective targeting and counter-targeting is a key lesson for Taiwan from the war in Ukraine. The PRC will certainly make heavy use of drone technology in any invasion scenario, and Taiwan's ability to limit their effectiveness will be among the principal tasks for electronic warfare and air defence forces.[241] Citizens themselves will also be an important source of information, as smartphones and private cameras will surely pick up on PLA movements in case of a successful landing of PRC forces. Merging this public collection into HUMINT collection has helped Ukraine, and would help Taiwan. Electronic intelligence will be an especially important asset given a likely heavy EW effort by Chinese forces to digitally isolate the island from its backers and disrupt communications on the island itself.

Overall, the war against Ukraine clearly shows that arresting an initial assault achieves the most immediate objective of government preservation, while armed forces can adapt surprisingly well to rectify initial failures and previous advantages gained by success can be lost or degraded over time. In C4ISR, it requires each of the three main elements, command, communications, and intelligence to be robust, survivable, and adaptable to changing circumstances. Lessons on C4ISR and their implications are summarised in Table 1.

Table 1. Summary table of C4ISR lessons and their implications

	Applicable C4ISR Lessons	Implications/Benefits
Command	Civil-military trust and clarity of responsibilities	Effective coordination and transfer of authority
	Unity of command	Clarity of command
	Mission command	Resistance to strikes and strike capabilities enhancement
Communication	Resilient and off-island communication systems and infrastructures	Stable coverage, facilitating global coordination
Intelligence	Military-civilian intelligence services cooperation	Facilitated information flow and increased accuracy of assessments
	Electronic intelligence and warfareinnovation	Effective targeting and counter-targetingand resistance to disruptions

239 Russell Hsiao, 'Taiwan's Military Intelligence Undergoing Reforms amid Growing Threats from the PLA' (Washington, D.C.: Global Taiwan Institute, 9 August 2023), https://globaltaiwan.org/2023/08/taiwans-military-intelligence-undergoing-reforms-amid-growing-threats-from-the-pla/.

240 Hsiao.

241 'Transcript Online Event: "Ukraine and Taiwan: Parallels and Early Lessons Learned"', Centre for Strategic and International Studies, 22 March 2022, 6, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220322_Lin_Ukraine_Taiwan.pdf?VersionId=MW97UcgRPLODcGm04A38P3EKBnNoQgGN.

6.2. **The Land Domain**

What a land fight in Taiwan could look like is an open discussion amongst experts. In the fieldwork conducted in Taiwan in the context of this study, there is scepticism as to whether the PLA would attempt a high-risk amphibious or air assault operation to take the island. The physical layout of the country heavily favours a defender, with there being on average 50 kilometres between any landing beach and the heavily mountainous interior of the country. In the flatter, western part of the country, there are crisscrossing rivers, wide swathes of agricultural areas, and heavily urban population centres. From the topography alone, it is relatively easy to see how a landing force could become bogged down and subjected to heavy fire from defenders.

When it comes to lessons from Ukraine, another factor to highlight is the element of combat experience. Each of the states in this study, Russia, Ukraine, the PRC, and Taiwan, are similar in that they all have conscription-based land forces with a core of professional troops. Where they differ is that both Russian and Ukrainian land forces now have deep experience in land operations. Both sides have experience with multiple rounds of force generation, attrition, reconstitution, and integrating professional and conscript forces. Mobilisation at this scale is difficult to do in theory or in exercises. Nevertheless, though there are noticeable differences, there is much that is applicable across the cases.

6.2.1. **Lessons and Implications**

The lessons from the land domain from the war against Ukraine with relevance for Taiwan are relatively straightforward albeit quite general given the vast differences in geographical makeup between the two countries.

First and foremost, both the failure of the invasion in its initial stages and the dogged ability of Ukraine to fight off an invader who is willing and able to incur massive numbers of casualties demonstrates the relevance of layered defence and the utility of a strategy aimed at area denial. Such a strategy is based on prepared positions with trenches and obstacles and urban terrain as well as natural barriers such as rivers, and in the case of Taiwan, mountains, to block the invader's access or inflict enormous costs for every inch of territory.[242] It also makes use of denial capabilities manifested in decentralised units engaged in hit-and-run tactics as well as the large-scale use of drones to execute area denial.

Russia's adaptation in the second and latter phases of the campaign bears this lesson as well. The various layers of defensive lines that Russia has established on territories in control have slowed and even stopped Ukrainian counteroffensive efforts. Combat engineering on both sides has not only served a basic force protection function but also locked battle lines in some areas to facilitate manoeuvres elsewhere. This then naturally turned into a countermeasure battle where each side has adapted to overcome the other's defences, including the use of drones.[243]

Second, and related to area denial, the Russia-Ukraine war shows how defenders can leverage increased battlefield transparency because of the overwhelming prevalence of

[242] Viktoriya Fedorchak, 'Lessons Learned from the War in Ukraine Applicable to Taiwan: The Land Domain' (The Hague Centre for Strategic Studies, December 2024), 4.

[243] Mick Ryan, The War for Ukraine, Strategy and Adaptation Under Fire, Naval Institute Press, August 2024. 191-194 on drones specifically.

macro (satellites) and micro (drones) assets. The tactical intelligence provided by UAVs is a force amplifier for traditional weapon systems including artillery. This creates a situation of ”nowhere to hide” which makes it prohibitively costly to group large force concentrations both for defenders and offenders. It necessitates doubling down on cover and concealment efforts alongside small-unit initiative and the ability to disperse before if only temporarily concentrating force. Further, drones doubling as ISR and strike assets allows for quick action once a target has been identified.

Third, logistics are crucial to attacking, occupying, and holding land. Poor logistical planning and weak supply chains based on limited knowledge of the territory whether because of outdated maps, slow information circulation, or unfamiliarity with the wider social arena in which the invader moves, slows down offensive operations and increases the vulnerability of incoming units. This was on best display in the early phases of the war as a 64-kilometre-long convoy of Russian forces became bogged down north of Kyiv due to traffic and maintenance issues, which then quickly evolved into food and fuel issues. Such a large, lumbering target is also an easy target for defenders. For Ukraine, similarly, being able to resource its war effort has been one of the key preoccupations of the political and military leadership. Shortages of ammunitions and manpower has had direct effects on military-operational planning throughout the war.

Fourth, the morale amongst ground troops is vital. Breakdowns in small unit cohesion hinder everything from localised operations to wider mobilisation and even civil-military relations. Being able to sustain a years-long, trench warfare fight against a larger adversary requires serious resolve, one that is best explained by Ukrainian troops defending their own country. Whereas Russian resilience on the front line is maintained through inhumane training practices and brutal discipline, Ukrainian forces have kept on the line in defence of their own lands.

Overall, for the land domain, the war demonstrates the use and utility of layered defence, the value of area denial leveraging ubiquitous pervasive transparency and on the ability to hit everything that moves on the battlefield, the continuing relevance of logistics and supply to execute and sustain military operations, and finally, the fundamental importance of morale to keep up the fight. Lessons on the land domain and implications are summarised in Table 2.

Table 2. Summary table of lessons and their implications on the land domain

Lessons Applicable to the Land Domain	Implications
Importance of combat engineering, UAS, and denial capabilities	Layered defence and area denial
Use of macro and micro tactical intelligence assets	Enhanced battlefield transparency
Extensive logistics planning	Lower vulnerability through robust supply chains
Importance of strong morale and social cohesion	Increased troops resilience

6.3. **The Air Domain**

Like in the case of Ukraine, an air war over Taiwan would likely be heavily shaped by salvoes of missile strikes attempting to knockout Taiwan's air forces and air defences early in an attack. Further, like Ukraine, this initial attack would be heavily dependent on pre-war conditions. If such an attack begins after a blockade of the island is in force, then Taiwan would face a 360-degree threat, with a People's Liberation Army Navy (PLA-N) aircraft likely deployed east of the island in such a scenario.[244]

When it comes to contingencies and caveats, there are of course specifics to the Ukraine conflict. Russia's initial air campaign in Ukraine was hampered by poor preparedness and logistical shortcomings, which may not apply to a potential conflict over Taiwan where China's air capabilities and operational readiness are different. The jointness between Russian air and other operations also lacked significantly.

Additionally, support from third parties remains one of the biggest caveats in the air domain. Ukraine benefited from substantial and sustained support from the US and NATO, both in terms of ISR capabilities and in the form of the provision of advanced air defence systems, which may not be able to be replicated for Taiwan in a similar capacity. In this sense, the geographic position of Ukraine, which shares a contiguous land border with several European states, facilitated the unimpeded flow of military supplies from continental Europe to Ukraine. Taiwan, an island relatively far from its most prominent air defence suppliers, might face more direct and complex challenges in securing external supply lines, especially in the face of Chinese opposition.

Lastly, favourable weather conditions and unforeseen events, such as the cessation of Russia's SEAD campaign, played an unexpected role in Ukraine's resilience but cannot be counted on in a hypothetical Taiwan conflict. Indeed, most scenarios related to a PLA assault on Taiwan foresee an initial massive missile and drone salvo against sensitive targets, followed by a persistent campaign against Taiwanese airfields and air defence sites. Relatedly, any prolonged campaign, extending into months, would have to contend with southeast Asia's monsoon season. Despite these caveats, there are of important air domain lessons to be distilled for Taiwan.

6.3.1. **Lessons and Implications**

Several key lessons can be learned from the war in Ukraine. First, attaining persistent air superiority will likely be challenging for most conflict actors, also in situations featuring clear asymmetric balances of capabilities. The inability to establish air superiority has forced Russia and Ukraine to engage in a prolonged, land-centric war of attrition along an extended front line.[245] While for reasons of geography, this will not be the case for Taiwan, it should be prepared to face Chinese attempts to establish command of the skies.

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[244] For an overview of different scenarios including (1) Landing a knock-out punch: a sea-land invasion, (2) Strangling the porcupine: a semi-permanent blockade, and 3. Boiling the frog: an on-and-off blockade, see our HCSS study Joris Teer, Davis Ellison, and Abe de Ruijter, 'The Cost of Conflict: Economic Implications of a Taiwan Military Crisis for the Netherlands and the EU' (The Hague Centre for Strategic Studies, March 2024); For the storylines in 12 slides, see 'Slide Deck: The Cost of Conflict: Economic Implications of a Taiwan Military Crisis for the Netherlands and the EU', accessed 24 December 2024, https://hcss.nl/report/cost-of-conflict-economic-implications-of-taiwan-military-crisis-netherlands-eu/.

[245] Fedorchak, 'Lessons Learned from the War in Ukraine Applicable to Taiwan: The Land Domain', 4.

Particularly in the early phases of the Russian invasion, Ukraine's ability to deny Russian air advantages was critical for its ability to stave off the initial shock attacks and continue the fight. For Taiwan, given its geography and the air approaches to China, a strategy aimed at air denial, as part of broader denial strategy, will be critical to its ability to mount a robust defence.[246]

Second, and related to the first point, IAMD systems will play an essential role. Ukraine's ability to effectively counter Russian attacks was largely due to the rapid deployment of advanced air defence systems, including US-supplied Patriot missiles and its use of Soviet-era systems such as the S-300, enabling it to offset Russian quantitative advantages. Two elements were key in achieving this: sufficient density of assets and coordination where to deploy them based on effectively functioning C4ISR. Taiwan, confronted with a potentially overwhelming air threat from China, will need to further strengthen the island's air defence infrastructures. This firstly means expanding the numbers of air defence systems by increasing the quantity of advanced interceptors, radar platforms, and launchers to ensure coverage across Taiwan's entire airspace, as well as enhancing stockpiles of munitions.[247] In addition to increasing redundancy, by expanding the numbers of these systems, boosting coordination (as discussed in the C4ISR section), and enhancing mobility to allow for the dispersal of these assets in its mountainous regions, it will also require strengthening counter EW abilities to take on PRC's EW attacks.

The third and rather obvious lesson for the air war domain is the increasing importance of drones of all sizes for all purposes both military and commercial grade.[248] The war in Ukraine shows how both parties have deployed relatively inexpensive drones in large quantities for reconnaissance and surveillance purposes, in the process creating battlefield transparency, and for targeting and strike missions, both on the battlefield and in rear areas, from the air, in the sea, and on land.

Taiwan will similarly benefit from integrating drones into its defence posture, both for reconnaissance and surveillance of the PLA's naval and air movements, and for precision strikes against military assets of an invading force. Drones offer Taiwan a relatively cost-effective means to increase its asymmetrical deterrence against a more powerful adversary as part of a broader denial posture. As part of that process, Taiwan will have to address the vulnerability of drones to advanced anti-drone measures and challenges related to the limited range of especially commercial-grade drones. Ukraine's experience with drones has not only clearly demonstrated their value, but also their dependence on secure networks and logistics. For Taiwan, it will be important to invest in resilient drone systems that can operate in contested battle spaces whether through EW or kinetic means. Lessons on the air domain and implications are summarised in Table 3.

246 Peter Wijninga, 'Lessons in Airpower' (The Hague Centre for Strategic Studies, December 2024), 5–6.

247 Matthew Revels, 'Denying Command of the Air: The Future of Taiwan's Air Defense Strategy', *Journal of Indo-Pacific Affairs*, April 2023, https://www.airuniversity.af.edu/JIPA/Display/Article/3371516/denying-command-of-the-air-the-future-of-taiwans-air-defense-strategy/https%3A%2F%2Fwww.airuniversity.af.edu%2FJIPA%2FDisplay%2FArticle%2F3371516%2Fdenying-command-of-the-air-the-future-of-taiwans-air-defense-strategy%2F; Michael J. Lostumbo et al., 'Air Defense Options for Taiwan: An Assessment of Relative Costs and Operational Benefits' (RAND Corporation, 5 April 2016), https://www.rand.org/pubs/research_reports/RR1051.html.

248 Wijninga, 'Lessons in Airpower', 6.

Table 3. Summary table of lessons and their implications on the air domain

Lessons Applicable to the Air Domain	Implications
Necessity of air denial capabilities	Protection of military and civilian infrastructures
Assets density, extensive coverage, and effective C4ISR-based coordination	Rapid and agile IAMD systems deployment
Large-scale use of drones of all types	Enhanced battlefield transparency
Integration of drones in defence strategies and resilient networks	Increased deterrence

6.4. The Maritime Domain

The geography of the Black Sea and the seas surrounding Taiwan are, of course, very different. A PRC attack against Taiwan will be maritime-focused by default. Taiwan would not be in a situation similar to Ukraine with Türkiye's closure of the Bosporus, preventing reinforcements from all sides.[249] Depending on pre-war force dispositions, Taiwan may already be surrounded on three sides by the PLA-N on day zero. Indeed, a blockade scenario prior to a full-scale attack or invasion attempt is quite likely, and features prominently in wargames, scenarios exercises, and is reflected in PLA-N naval doctrine.[250]

A second caveat is the scale of the PLA-N as compared to the correlation of forces in the Black Sea between Ukraine and Russia. While the Ukraine-Russia case was also heavily asymmetric, the Taiwan-PRC case is even orders of magnitude larger. The PLA-N is the largest naval force in the world, and given the importance of Taiwan to the PRC and the risks Beijing would be taking in a possible conflict with the US and its regional allies, it would likely commit the bulk of its naval power to such a war. This would then leave Taiwan, especially at the outset of the war, faced with nearly the full force of the largest navy in the world. As in other domains, Taiwanese defence would have to be nonlinear from the outset.

Relatedly, the third caveat here is the reliability of foreign support for Taiwan in the event of an invasion. Should the US and most (if not all) of its regional allies commit to the direct defence of the island at the outset of a conflict, the naval balance tips precipitously. From across domains, if American naval and land forces committed sea denial capabilities to help block the Taiwan Strait and attack PLA-N assets stationed east, south, and north of the island, significant

249 Jyh-Shyang Sheu, 'Lessons for Taiwan: From the Russo-Ukrainian War' (The Hague Centre for Strategic Studies, December 2024), 1.

250 In addition to Joris Teer, Davis Ellison, and Abe de Ruijter, 'The Cost of Conflict: Economic Implications of a Taiwan Military Crisis for the Netherlands and the EU' (The Hague: The Hague Centre for Strategic Studies, March 2024), https://hcss.nl/report/cost-of-conflict-economic-implications-of-taiwan-military-crisis-netherlands-eu/, see also Roger Cliff, *China's Military Power: Assessing Current and Future Capabilities* (Cambridge, UK: Cambridge University Press, 2015), 26; Mark F. Cancian, Matthew Cancian, and Eric Heginbotham, 'The First Battle of the Next War: Wargaming a Chinese Invasion of Taiwan', CSIS International Security Program (Center for Strategic and International Studies: Washington, D.C., January 2023), https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/230109_Cancian_FirstBattle_NextWar.pdf?VersionId=WdEUwJYWIySMPIr3ivhFolxC_gZQuSOQ; Stacie Pettyjohn, Becca Wasser, and Chris Dougherty, 'Dangerous Straits: Wargaming a Future Conflict over Taiwan', Center for a New American Security, 15 June 2022, https://www.cnas.org/publications/reports/dangerous-straits-wargaming-a-future-conflict-over-taiwans.

pressure would be taken from Taiwan, which could then focus on direct island defence. The question, of course, is if the US and its allies would be willing and able to muster such support and, crucially, do so in sufficient time. If the PLA-N has already surrounded the island and conducted mass strikes across the country early, it would be difficult for foreign backers of Taiwan to turn back the tide, or at least do so in a way that does not make any Taiwanese victory a Pyrrhic one.

6.4.1. Lessons and Implications

At a higher level, the lessons of the Russian invasion of Ukraine at sea is that sea denial is possible in an asymmetric fight. Especially once established in the early phases of a conflict, a defender with a significant arsenal of missiles and drones can make life painful for naval forces attempting to operate in its vicinity. This is the logic of the porcupine defence. Relatedly, such denial can be maintained for long periods of time if sufficient munitions are available. Ukraine, despite not having a navy with surface combatants, has denied Russia's use of the Black Sea to full effect for nearly three years.[251]

In the case of Taiwan, a sea denial approach depends on the PRC's chosen strategy and operational concept for an attack. If, like Russia, the aim is to take a huge risk by staging a full-scale invasion with an attempt to assert control over the entire country, then sea denial is of prime importance to prevent the arrival of PLA amphibious forces. If the aim is to surround the island and attempt to pound it into submission with massed missile, rocket, air, and drone strikes, then the capabilities for sea denial can contribute to island defence by targeting PLA-N platforms but would not be the centre of gravity for the conflict. Should the PRC instead opt for a blockade, then these same sea denial weapons can impose possibly unacceptable risks to the PRC.

In terms of capabilities, as noted throughout, investments into mass quantities of anti-ship and even anti-tank missiles are necessary to achieve effective sea denial from an independent national defence perspective. The already programmed Hsiung Feng II and III anti-ship missiles are an important investment in this regard and should be stockpiled at the highest quantity logistically and financially feasible. The same can be said for drones of various types, in the air and both on and under the sea. Coupling large-scale missile strikes with drone attacks against PLA forces could be a core operating concept for Taiwan armed forces. Finally, mine warfare to defend harbours, landing beaches, and to hinder any littoral mobility is crucial and requires maintained investment.

Improving this strike capability runs alongside the need for the maintenance of sufficient IAMD and infrastructure redundancy, dispersal and hardening to ensure vital military assets are not eliminated in early PLA missile salvoes. For the navy specifically, this would likely mean distributing forces and mounting a counterattack quickly as indicators and warnings come in. Within this planning would come difficult trade-offs when it comes to the security of the outlying islands. It is perhaps possible that deployments of marines to the Matsu, Wuciou, Penghu, and Kinmen islands armed with various missile and drone assets could help to slow the early phases of a conflict and perhaps even degrade some vital PLA-N assets before they can be brought to bear against the main island even the timing of such deployments would have to be balanced against escalatory tendencies.

[251] Alessio Patalano, 'The Maritime War in Ukraine: The Limits of Russian Sea Control?' (The Hague Centre for Strategic Studies, December 2024), 6.

Finally, there is the question of sustaining a strategy of sea denial. Ukraine benefits from long land borders with allied states. Taiwan, naturally, does not. The early phases of an attempted full-scale invasion would be massively resource intensive, and past the several-week mark would almost certainly require foreign assistance. The first order aim then is to impose such a cost in the early phase that the attempt is aborted, and if not, to keep sea lines open enough to ensure neighbouring supporters can provide military aid. In the following phases, should sufficient surface and submarine assets survive, the Taiwanese navy would need the capacity to reconstitute and refit to contribute to any counteroffensives or to repel a repeat assault. Lessons on the maritime domain and implications are summarised in Table 4.

Table 4. Summary table of lessons and their implications on the maritime domain

Lessons Applicable to the Maritime Domain	Implications
Preparedness through missile and drone arsenal building and mine warfare	Effective sea denial
IAMD infrastructure redundancy, dispersal and hardening	Resilient military assets and rapid counterattack capacity
Securing sea lines for foreign assistance and resourcesupply	Resilient sea denial and rebuilding capacity

6.5. Non-domain specific takeaways

It would be reductive to reflect only on those military domain areas discussed in the chapters above. There are several remaining domain transcending areas left to address as well. These areas are what military analyst Mike Martin refers to as the "intangible fundamentals": strategy and intelligence, logistics, morale, and training.[252] Both intelligence and logistics have been covered in some detail in the C4ISR and land lesson sections above, though it is important to stress the importance of both across each domain. The design of military (and civilian) intelligence organisations and the way logistics features in strategy, what Martin calls an "underpinning philosophy in how you fight", are vital features of each area. Given that they have been covered above, this section primarily focuses on morale and training.[253]

6.5.1. Morale

Morale is a crucial underpinning piece of maintaining a cohesive force, as already covered briefly in the land section above. At the individual, small unit, and larger formation levels, morale is a critical building block of the resilience of troops to face the terror of combat and to prevent disintegration in the face of attack. Building morale encompasses mutual trust and respect within and between enlisted and officers, progressively more difficult training to build confidence, high-quality and high-integrity leadership, and "firm-but-fair" discipline.[254]

[252] Mike Martin, *How to Fight a War* (London: Hurst Publishers, 2023), 30.

[253] Martin, 27.

[254] Martin, 59.

From historian Martin van Creveld, it is essential that a soldier knows that they are "a member of a well-integrated, well-led team whose structure, administration, and functioning were perceived to be, on the whole, equitable and just."[255]

There are important lessons from both the Ukrainian and Russian forces for any military, including Taiwan's. For much of the war, the Ukrainian morale remained quite high, due in large part that the Ukrainian forces were defending their own territory.[256] Further, with the development of a well-trained corps of professional troops, buttressed by an non-commissioned officer (NCO) system, the Ukrainian forces across services were well prepared. Early victories on the northern front to defend Kyiv, repel the assault on Hostomel Airport, and force a Russian withdrawal from the entire northern flank in the first phase undoubtedly also played an important role.

On the Russian side, the situation has been quite different. The Russian armed forces have, since the Soviet times and arguably earlier, been inculcated with a culture of brutality and corruption. At the individual training level, junior conscripts are subjected to *dedovshchina*, or "rule by the old timers", something described by Chechen Wars veteran Arkady Babchenko as a "set of unofficial rules, a kind of a code of laws, which if violated, incur corporal punishment."[257] Further, corruption throughout the Russian forces have left troops without "rations, warm clothing, properly fitting gear," and even ammunition.[258] There have been thousands of desertions recorded in Russian courts, though it is near impossible to calculate how many Russian servicemembers have attempted to desert the war.[259]

Morale is difficult to sustain over a longer period, however. Even in Ukraine, desertions have started to increase. As some units have served without rotation for nearly two years under heavy combat conditions, all while their families are subjected to air and missile strikes against their home cities, it becomes harder and harder to stay on the line. Nearly 30,000 criminal cases have been opened against soldiers abandoning their posts in 2024 alone.[260] The routine extension of service contracts beyond initial dates has contributed to this as well.

The sagging morale on both sides of the war has an important lesson for Taiwan, especially given its isolated island position: the longer a war continues, the weaker the cohesion seen in early phases is likely to become. Early victories may therefore be crucial, for both military and civilian morale: "there is nothing more corrosive…than defeat on the battlefield."[261] If anything, the Russia-Ukraine war demonstrates of the importance of force morale and the effects of not addressing this intangible directly.

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255 Martin van Creveld, *Fighting Power: German and U.S. Army Performance, 1939-1945*, Contributions in Military Studies 32 (Bloomsbury Academic, 2007), 163–64, https://www.barnesandnoble.com/w/fighting-power-martin-van-creveld/1119662116.

256 Luke Mogelson, 'Two Weeks at the Front in Ukraine', *The New Yorker*, 22 May 2023, https://www.newyorker.com/magazine/2023/05/29/two-weeks-at-the-front-in-ukraine.

257 Bachenko, 81.

258 Philip Wasielewski, 'The Roots of Russian Military Dysfunction - Foreign Policy Research Institute' (Foreign Policy Research Institute, 31 March 2023), https://www.fpri.org/article/2023/03/the-roots-of-russian-military-dysfunction/.

259 Sarah A. Topol, 'The Heavy Toll of Desertion From the Russian Army', *The New York Times*, 22 September 2024, sec. Magazine, https://www.nytimes.com/2024/09/22/magazine/desertion-russian-army-ukraine-war.html.

260 Sergii Kostezh, 'Desertion From Ukraine's Armed Forces – Will New Mobilization Laws Help?', Kyiv Post, 27 September 2024, https://www.kyivpost.com/post/39622.

261 Martin, 62-63.

6.5.2. **Training**

Beyond morale is training, ensuring the basic fitness of individuals, building small units into effective combat elements, and scaling onward towards a fully trained and exercised joint force. Training is about putting forces into progressively more difficult scenarios that come closer and closer to resembling actual combat.[262] If training is insufficiently realistic or if larger exercises are overly scripted, forces will be unprepared for the shock of combat against an adaptive adversary.

In the Russian invasion of Ukraine, there were obvious deficiencies amongst the Russian troops that military observers could identify. Small units were filmed in the first days of the campaign coming under fire and failing to take cover, coalescing into small clusters presenting an easy target, and firing wildly in response. In this first phase, a viral line from an interview with an anonymous Ukrainian soldier was "We are very lucky they are so stupid." Much of this was attributed at the time to poor training in combination with a lack of clear information for units that went into Ukraine on 24 February. The short training cycles for Russian conscripts, in particular, had been noted for some time as perfunctory and based more on on-the-job training than occupational speciality development.[263]

However, the adaptivity of the Russian forces after the first phase of the war has shown that its corps of contract servicemen can perform much better as learning takes hold. Training cycles have also improved as veterans of the war have been able to come off the line and train both conscripts and contract replacements. Indeed, as put by Russia scholar Dima Adamsky, the roots for improved initiative in training and military development had been set for nearly a decade by the time of the invasion. Once small-unit leaders faced combat, training deficiencies were overcome through sheer attrition and the survival of veterans who can pass lessons on to others.[264]

For the Ukrainians, there had been a sea change from 2014 to 2022 when it came to training and force development, a factor largely missed by pre-war analyses.[265] Partly with assistance from NATO partners, Ukraine had developed a relatively effective NCO corps and instituted rigorous training regimes, leveraging the experience of frontline troops' experiences in the years-long fight against Russia in Donbas to teach others.[266]

As the war began, Ukrainian forces, especially newly conscripted troops, were sent to train with NATO forces both inside Ukraine and across Europe. The impact of this training has been a subject of dispute amongst Ukrainian forces and NATO's experts, with some accusing that the NATO "way of war", based on air superiority and rapid manoeuvres, was not suited to a high-attrition, transparent battlefield without air dominance. Some in Ukraine and elsewhere would attribute the NATO training as a contributing factor to the failure of the

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262 Marting, 67.

263 Charles K. Bartles, 'Russian Armed Forces: Enlisted Professionals', *NCO Journal*, 11 March 2019, https://www.armyupress.army.mil/Journals/NCO-Journal/Archives/2019/March/Russian-NCOs/.

264 Dmitry (Dima) Adamsky, 'Discontinuity in Russian Strategic Culture? A Case Study of Mission Command Practice', Security Insights (George C. Marshall European Center For Security Studies, February 2020), https://www.marshallcenter.org/en/publications/security-insights/discontinuity-russian-strategic-culture-case-study-mission-command-practice-0.

265 Cohen, O'Brien, and Strachan, 'The Russia-Ukraine War'.

266 Mick Ryan, 'The Battle to Adapt to Russia's Evolving War Tactics Is Essential If Ukraine Is to Emerge Victorious', Lowy Institute, 18 July 2023, https://www.lowyinstitute.org/publications/battle-adapt-russia-s-evolving-war-tactics-essential-if-ukraine-emerge-victorious.

long-awaited autumn 2023 Ukrainian counteroffensive, which faltered in the face of Russian defensive lines.[267]

Training, then, is not consigned to a static, pre-war function. Both Russia and Ukraine have adapted and changed training regimens in response to combat lessons. For Taiwan, several important implications can be found. First, mobilised conscripts require more than the bare minimum in training and will require a fair amount of refreshment in the event of war. Second, maxims derived from an American "way of war" should be treated with caution, it being based on a huge defence apparatus that Taiwan simply does not have. Any external lessons or training should be balanced by the adaptiveness of those lessons to the specific case of Taiwan. Finally, realism in training is crucial. If troops have no idea of the realistic conditions under which they will fight, real risks can be exposed in the early phases of a war as shock and survival instincts battle to overcome training.

[267] Jamie Dettmer, 'Ukraine's Forces Say NATO Trained Them for Wrong Fight', *Politico*, 22 September 2023, https://www.politico.eu/article/ukraine-war-army-nato-trained-them-wrong-fight/.

7. Conclusions and Recommendations

From the pre-war period to the initial invasion, and all the subsequent phases of the war as of writing, there are tangible and intangible lessons in C4ISR and the land, air, and sea domains from the Ukrainian battlefield for a potential contingency over Taiwan. The campaign analysis from Ukraine has highlighted how the ability to adapt in wartime is a hugely influential element in deciding the outcome of wars, something which has been extensively studied by military scholars.[268] Our analysis, using both pre-war assessments and analysis of wartime adaptations by both sides, has identified a series of implications for Taiwan which have been elaborated at length in Chapter five.

Pre-war assessments are always tricky and are impacted by the biases of the authors. To control for these biases, we have consulted a wide range of sources on the Russian invasion, relied on a variety of scenario exercises related to Taiwan, consulted with experts on the Russian, Ukrainian, Taiwanese, and Chinese militaries, and conducted a field visit to Taiwan itself. We have especially guarded against some of the misconceptions related to expert judgment on the Russian invasion of Ukraine. The aim has been neither to over- nor to under-estimate any of the actors studied in this report.

This report has also stressed repeatedly the differences in geography, politics, international situation, and force designs that impact a Ukraine-Taiwan comparison. No study of this type can claim full transferability of lessons from one theatre to the next. The effort here has been to right-size the assessment to tease out those details that are most relevant for Taiwan. The implications range from higher-order discussions on the relationship of commanders to political leadership all the way down to the need for specific capabilities. Each has been singled out for discussion with Taiwan's unique position in mind.

For the Taiwanese forces, Ukraine's defence has highlighted across domains the possible utility of a denial strategy. The objective of a denial strategy is to frustrate the PRC's invading military forces by preventing them from using and exploiting their strengths in the land, air, and maritime domains. As a result, a denial strategy increases the cost of aggression directly before, during, and after a possible PRC invasion.[269]

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268 On this war, see Mick Ryan, The War for Ukraine, Strategy and Adaptation Under Fire, Naval Institute Press, August 2024. On other wars, see Frank Hoffman, *Transforming War- Mars Adapting: Military Change During War* (Annapolis: US Naval Institute Press, 2021); Chan, 'The Adaptation Battle: The PLA and Lessons from the Russia-Ukraine War'; Lt General David Barno and Nora Bensahel, *Adaptation under Fire: How Militaries Change in Wartime*, Bridging the Gap (Oxford: Oxford University Press, 2020); Raphael D. Marcus, *Israel's Long War with Hezbollah: Military Innovation and Adaptation Under Fire* (Georgetown University Press, 2018), https://doi.org/10.2307/j.ctv75db9b.

269 Samuel Zilincik and Tim Sweijs, 'Beyond Deterrence: Reconceptualizing Denial Strategies and Rethinking Their Emotional Effects', *Contemporary Security Policy* 44, no. 2 (3 April 2023): 248, https://doi.org/10.1080/13523260.2023.2185970; Paul van Hooft, Nora Nijboer, and Tim Sweijs, 'Raising the Costs of Access: Active Denial Strategies by Small and Middle Powers Against Revisionist Aggression' (The Hague Centre for Strategic Studies, 24 December 2021), 3; 7–8.

We do note that there are debates as to the likelihood and feasibility of a full-scale PLA assault against the main island of Taiwan.[270] This was further discussed in our field visit. We recognise that grey-zone challenges, which fall outside the scope of this report, are a pressing concern for Taiwan and were prevalent in the pre-war environment for Ukraine as well.[271] We maintain our argument, however, that a denial strategy is ideal for Taiwan and validated by Ukraine's experience and is one that can even more readily counter grey-zone pressures as well.[272]

Further reinforcing the argument for denial is the likely infeasibility of a deterrence-by-punishment strategy for Taiwan. Even if this is itself open for debate, and would merit further study in and of itself, there are considerable escalatory risks involved with a punishment strategy. The primary argument is that a punishment strategy requires a more even balance of forces and that it is difficult to do against a nuclear power due to escalation risks.[273] More importantly, denial strategies depend less on conditions that undermine the efficacy of punishment strategies.[274] In the case of Taiwan, denial strategies are less likely to be misinterpreted by the PRC because Taiwan can communicate not just the presence but also the effectiveness of denial capabilities both through exercises and demonstrations.[275] Moreover, once deterrence by denial fails, and the PRC attacks, Taiwanese denial capabilities can be used for the actual defence of the island. A denial strategy can be instrumental in frustrating a possible attack across different domains and along different attack vectors.[276]

A Taiwanese denial strategy is rooted in a force posture aimed at denying a PRC invasion force the ability to achieve a swift victory. It is rooted in a resilient society and a military that is able to withstand strikes and still operate, whilst targeting and weakening the adversary's forces.[277] It is unlikely that Taiwan will be able to survive for a longer period without support. A denial strategy therefore seeks to prevent the PRC quick military victory, significantly raise the costs of an invasion attempt, and create a situation in which external supporters can come to Taiwan's aid.

To achieve denial, Taiwan should further pursue capabilities that adhere to multiple denial logics, including operational paralysis, tactical degradation and strategic effect reduction.[278] Operational paralysis is aimed at "prevent[ing] the adversary's military power from reaching its target" in the first place.[279] If operational paralysis fails, then tactical degradation comes into play by inflicting as much damage on the incoming forces as possible. Strategic effect reduction, finally, renders the enemy's military forces irrelevant by creating a situation in which

[270] Jude Blanchette and Bonnie Glaser, 'Taiwan's Most Pressing Challenge Is Strangulation, Not Invasion', War on the Rocks, 9 November 2023, https://warontherocks.com/2023/11/taiwans-most-pressing-challenge-is-strangulation-not-invasion/; Teer, Ellison, and de Ruijter, 'The Cost of Conflict: Economic Implications of a Taiwan Military Crisis for the Netherlands and the EU', March 2024.

[271] Jacob Strokes, 'Resisting China's Gray Zone Military Pressure on Taiwan' (Center for New American Security, 7 December 2023), https://www.cnas.org/publications/reports/resisting-chinas-gray-zone-military-pressure-on-taiwan; Lukas Milevski, 'When Does Gray Zone Confrontation End? A Conceptual Analysis', *Joint Force Quarterly* 112 (15 February 2024): 4–11.

[272] Michael J. Mazarr et al., 'What Deters and Why: Applying a Framework to Assess Deterrence of Gray Zone Aggression' (RAND Corporation, 19 April 2021), https://www.rand.org/pubs/research_reports/RR3142.html.

[273] Christopher Preble, Zack Cooper, and Melanie Marlowe, 'Debating the Defense of Taiwan, January 2023', Net Assessment, 5 January 2023, https://warontherocks.com/2023/01/debating-the-defense-of-taiwan/.

[274] Zilincik and Sweijs, 'Beyond Deterrence', 249.

[275] Evan Braden Montgomery, 'Signals of Strength: Capability Demonstrations and Perceptions of Military Power', *Journal of Strategic Studies* 43, no. 2 (2019): 309–30.

[276] Zilincik and Sweijs, 'Beyond Deterrence', 249.

[277] Eric Heginbotham and Richard J. Samuels, 'Active Denial: Redesigning Japan's Response to China's Military Challenge', *International Security* 42, no. 4 (May 2018): 147–48.

[278] Zilincik and Sweijs, 'Beyond Deterrence'.

[279] Zilincik and Sweijs, 254.

their use brings no advantages. Key to a denial strategy are anti-access area denial (A2/AD) capabilities across different warfighting domains which have been further identified in Chapter Six.[280]

For Taiwan specifically, a force posture based on a denial strategy should be increasingly asymmetric in nature. To a degree, conflicts are always asymmetric in nature as opponents seek to exploit their advantages where they benefit from asymmetry. The term here, however, explicitly conveys the notion that Taiwan cannot afford to go toe-to-toe with the PRC in terms of conventional advanced military capabilities because it is severely outmatched if not in quality then definitely in sheer numbers. It should therefore seek other ways to balance the PRC's power preponderance by leveraging asymmetric advantages.

As such, this proposal and its constituent elements are far from revolutionary. Many of its key tenets were envisaged in the Overall Defence Concept (ODC) laid down by Admiral Lee in 2018, which sought, in his own words, to shift the definition of '"winning the war"' from 'totally destroying enemy forces' to 'fail[ing] the enemy's mission to occupy Taiwan.'[281] In dealing with China's the clear and growing imbalance in power, the ODC also emphasises the need for asymmetric assets – 'a large number of small things' – 'to complement existing traditional platforms' with a concept of operations that singles out 'force protection', 'decisive battle in the littoral zone' and 'destruction of the enemy at the landing beach'.[282] In October 2022, eight months after Russia's invasion of Ukraine, then-president Tsai called for the development of "comprehensive asymmetric warfare capabilities, ensuring that Taiwan is fully prepared to respond to external military threats" in her National Day Address.[283] The conclusions of our analysis align with these findings. It is now critical to double down on these efforts.[284]

Crucially, an 'asymmetric' denial strategy can inform an overall Taiwanese force posture, serve as a unifying element to guide the development of doctrine, the acquisition of capabilities, and the joint training and exercising of services, and thereby guide overall war preparation efforts.

A second overarching conclusion is that quality can indeed overcome quantity, but only to a point. In blunting the initial assault, well-trained forces across domains acting on quick orders and good intelligence, smaller forces can outperform larger, overconfident and underprepared adversaries. The challenge comes in the follow-on phases, where the balance shifts from quality towards quantity as attrition takes its toll. Quantity then becomes a quality of its own.[285] Ukraine has faced a large state operating under war economy conditions, and without foreign assistance would have simply been out-produced and out-mobilised through sheer

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280 Pei-Shiue Hsieh, 'Building Taiwan's Own Area Denial Capabilities', The Diplomat, 21 September 2022, https://thediplomat.com/2022/09/building-taiwans-own-area-denial-capabilities/.

281 Tommy Jamison, 'Taiwan's Theory of the Fight', War on the Rocks, 21 February 2024, https://warontherocks.com/2024/02/taiwans-theory-of-the-fight/; Hsi-min Lee, 'Taiwan's Overall Defense Concept: Theory and the Practice', 2, https://www.hoover.org/sites/default/files/210927_adm_lee_hoover_remarks_draft4.pdf

282 Joris Teer et al., 'China's Military Rise and the Implications for European Security' (The Hague Centre for Strategic Studies, November 2021), https://hcss.nl/report/chinas-military-rise/; Hsi-min Lee and Eric Lee, 'Taiwan's Overall Defense Concept, Explained', The Diplomat, 3 November 2020, https://thediplomat.com/2020/11/taiwans-overall-defense-concept-explained/; Mick Ryan, 'The Overall Defence Concept: Taiwan's Development of Comprehensive Asymmetric Warfare Capabilities', Substack newsletter, Futura Doctrina, 2 June 2023, https://mickryan.substack.com/p/the-overall-defence-concept.

283 'President Tsai Delivers 2022 National Day Address', Office of the President of the Republic of China, 10 October 2022, https://english.president.gov.tw/News/6348.

284 Preble, Cooper, and Marlowe, 'Debating the Defense of Taiwan, January 2023'.

285 On that specific point, see *Élie Tenenbaum on Élie Tenenbaum on Capability vs. Capacity in Multi-Domain Operations* (The Hague Centre for Strategic Studies, 2023), https://hcss.nl/hcss-nato-hq-sact-symposium/.

numbers.[286] For Taiwan and its international backers, this is an important point for planners. Sustaining defence in the longer term while under heavy attack is difficult. Doing so on an island far from its main partner is even more difficult. As part of giving teeth to an asymmetric denial strategy, Taiwan will need to prioritise voluminous and disposable assets that can be swiftly replaced at lower cost than highly advanced, extremely expensive, multirole platforms, and, at least in part, manufactured on the island itself.

Turning now to specific recommendations, we return to a domain-specific list.[287]

In C4ISR, the Ukrainian experience yields the following recommendations for Taiwan:

- **Ensure coherency in service-specific and joint command structures.** Guarding against 'stove-piped' command channels and against inter-service rivalries impacting operational effectiveness is essential. This requires pre-war discussions and exercises within and between service leadership teams to practice command and control arrangements under realistic wartime conditions.
- **Building and maintaining resilient communications systems with back-ups.** Being able to communicate amongst forces, to the public, and to the outside world is vital before and throughout conflict. Resilient communications systems, with back-ups outside the country, and ideally a combination of terrestrial and space-based, are needed. Importantly, this necessitates a well-resourced cyber defence and counter-EW effort.
- **Guard against dysfunction in the intelligence enterprise.** Competing organisations, mixed signals, and poor analysis are the ingredients for intelligence disaster. Divisions between various intelligence entities should be broken down as much as feasible, while dissent and frank discussion amongst intelligence collectors, analysts and decision makers should be fostered.
- **Invest in the proliferation of sensors.** Investing in drones of all classes and sizes, equipping units across services with them, and leveraging the wide availability of commercial data is essential for tasks ranging from pre-war collection to target acquisition. This capability should be maintained with as much independence as possible, to guard against over-reliance on foreign intelligence provision.

On land, the following lessons for Taiwan can be identified:

- **Forge layered defence networks.** Leveraging Taiwan's unique geography, the Taiwanese land forces can make the PLA's job incredibly difficult. From immediate defences on the outlying islands, from hardened areas around sea and air landing sites, urban areas, and finally the mountains, the island can accommodate several layers of engineered defensive fortifications and infrastructure. The land forces would have a central role in building and manning these layers of defences.
- **Increase battlefield transparency.** A consistent theme across domains, the integration of drones of various sizes into land operations is a trend that has emerged in conflicts across the globe. For ground forces, this includes enabling troops at the fire team (4 or so soldiers) to the squad level with tactical mini-drones and scaling upwards for company- and brigade-level units to be supported by larger ISR capabilities such as MQ-9 Reapers.

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286 Tim Sweijs and Jeffrey H. Michaels, 'Introduction', in *Beyond Ukraine: Debating the Future of War*, ed. Tim Sweijs and Jeffrey H. Michaels (Oxford University Press, 2024), 0, https://doi.org/10.1093/oso/9780197790243.003.0001.

287 These recommendations are based on the best available information provided through desk and field research. It is acknowledged that plans and approaches not publicly available could already be programmed.

- **Establish robust logistical chains.** The ground forces will have an important role to play in sustaining forces across the island in a range of scenarios. Ensuring redundant capacity across the range of combat support services (CSS) ranging from transport, storage, medical, maintenance, and engineering support will become the backbone of the armed forces in a more sustained campaign. Investment in CSS should further be based on the logic of redundant capacity, rather than "just in time" logistics. Attrition in the face of PLA attacks, given that strikes would certainly target logistics capacity, should be a factor in developing planning targets.

In the air, the ongoing war yields the following lessons:

- **Build up Integrated Air and Missile Defence (IAMD).** For Taiwan, as has been the case in Ukraine, highly capable IAMD with huge capacity is required not only to protect vital military facilities and forces but also to ensure civilians are protected and the government can continue to function. Maintaining a large number of Sky Bow, Strong Bow, and Patriot systems with a redundant mass of interceptors demands significant and sustained investments. This investment is core to the strategy and attendant operating concepts of denial.
- **Develop and acquire drones**. Commercial grade and military grade drones that are disposable, voluminous and relatively cheap and that can be in part produced on the island itself will provide an important enabler for ISR purposes and can be used for targeting and strike purposes in the defence of the island.
- **Develop and acquire counter-drone capabilities.** Heavy PLA investments in drones that would be coupled with missile strikes to degrade IAMD necessitate a counterinvestment in counter-drone technologies. This includes both kinetic interception and non-kinetic electronic warfare assets. Non-kinetic assets, including a line of site C-UAS 'guns' for smaller units, and larger space-enabled assets at dedicated electronic warfare sites. Coupling these sites with larger IAMD nodes guards against combined drone and missile strikes. The placing of these sites is of course a sensitive choice, balancing between civilian protection and military force protection.

At sea, we identify the following lessons for Taiwan:

- **Invest in naval strike capabilities.** Naval strike missiles, both AShMs and LACMs, will be important assets for both larger platforms and marine forces to have both capability and capacity. Mobile strike platforms enabled with these longer-range assets will be important to countering any attempted landings and stalling advances in the outlying islands. In denying the Taiwan Strait to the PLA-N, the Republic of China Navy (ROCN) will play a lynchpin role in a denial strategy.
- **Develop and acquire drones.** The Ukrainian raids on the Black Sea fleet in Crimea showed the capability of using combined USV and UAV attacks to remove any safe havens for naval assets. Possible PLA staging areas such as the PLA-N Fujian Base on Xiamen Island would be particularly vulnerable to persistent raiding in any ROCN counterattacks. The further afield the PLA-N is forced to base sensitive assets, the less likely an amphibious attack can succeed. Further, UUVs can be used in a denial role as well, filling the Strait with many, stealthy 'suicide UUVs' making any crossing increasingly prohibitive.
- **Develop mine warfare capabilities.** Like UUVs, mines in the Taiwanese littoral, especially around possible landing beaches and ports, will contribute to denying the PLA a beachhead. Of course, pre-emptive deployments of such weapons in peacetime are difficult economically and are a risk to civilian areas. Therefore, the capability to quickly deploy mines at scale is needed, whether air or sea delivered. De-mining capabilities are needed as well, as port infrastructure must be maintained in longer-term scenarios.

Drawing lessons from the ongoing war in Ukraine to a potential Chinese invasion of Taiwan is challenging, as takeaways can easily be too generic or too specific. Still, this report carefully identified key military insights for Taiwan. Strengthening civil-military coordination and inter-service collaboration is crucial for effective mission command. Enhanced communication technologies are needed to ensure seamless connectivity between civilian and military stakeholders, preventing operational disruptions. Additionally, robust intelligence networks, supported by drones and electronic systems, are vital for maintaining situational awareness and adaptability. Lastly, investments in ISR and IAMD systems, drones, missiles, counter-drone warfare, and mines can bolster defensive capabilities, provided they are supported by sustainment and realistic training. These lessons, forged on the battlefields of Ukraine, hold the potential to inform Taiwan's defence strategy, offering insights for resilience in the face of a looming Chinese offensive.

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