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Maritime Implications of the War in Ukraine

Electromagnetic Warfare and Sea Drone Defence as Fields of Action for the German Navy

The hostilities that have taken place in the Black Sea since the beginning of Russia's full-scale invasion of Ukraine on 24 February 2022 have attracted enormous attention worldwide. As the first European naval war since World War II – and the first naval war worldwide since the Falklands War in 1982, for that matter – Ukraine's naval campaign is of particular interest. Despite having had only a very small naval force incapable of three-dimensional naval warfare at the outbreak of the war, Ukraine has succeeded in restricting the operational capabilities of the most powerful fleet in the region – the Russian Federation's Black Sea Fleet. Ukraine has succeeded in denying its opponent the ability to control large parts of the Black Sea as well as in systematically wearing Russian forces down and physically destroying many of its high-value units.

In this context, a number of observers have already set out to analyse the naval part of Russia's war against Ukraine, drawing lessons for the maritime domain in general and for the German Navy in particular.

For instance, Sebastian Bruns and Heinz-Dieter Jopp have compiled a chronology of the events of the war in the Black Sea, discussed Russia's courses of action at the operational level and suggested measures such as the reduction of bureaucracy, the abandonment of 'gold-plated solutions' with regard to the establishment of powerful coastguard units and the standardisation of measures across Europe (e.g. to simplify joint approaches to designing and manufacturing products, to reduce costs, to simplify the stockpiling of spare parts and to create synergies) in order to increase Germany's capacity for action in the maritime domain.[1] NATO's *Russian War Against Ukraine Lessons Learned Curriculum Guide*, a handbook for military education institutions in NATO countries published in December 2023, summarises the essentials of a great variety of publications on the war in the Black Sea and derives valuable conclusions for NATO members and partners. For example, the *Curriculum Guide* underlines the necessity of a strong awareness of the need to continually change the positions of seagoing units in ports and bases, of the threat posed by missiles fired from coastal defence positions and of the use of unmanned aerial, surface and underwater vehicles. NATO's *Curriculum Guide* also draws attention to a possible need to establish forces suitable for

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1 Bruns/Jopp 2024: 56–57.

brown-water operations on large rivers.[2] Alexander Rosemann is another expert who has analysed the war in the Black Sea. He concludes that it is essential for the German Navy to contribute to strengthening the mine warfare capabilities of neighbouring countries – possibly within the scope of a ring exchange.[3]

This #GIDSstatement aims to contribute to the discourse on the war in the Black Sea by discussing two additional specific aspects of naval warfare – electromagnetic warfare (EW) and the defence against maritime unmanned systems (MUS) – and by identifying conclusions for own possible courses of action.[4] These are subject areas that have so far received little attention. At the same time, EW and (gaps in) the defence against MUS are factors that have had significant influence on the war in Ukraine and that also have important implications for the German Navy. For this reason, this #GIDSstatement will first focus on the description and evaluation of Russian and Ukrainian capabilities and their employment in the context of Russia's war against Ukraine, before drawing conclusions for the German Navy.[5]

The War between Russia and Ukraine in the Maritime Domain

At the beginning of the war, Ukraine's naval forces neither had any naval warfare assets nor capabilities allowing for symmetric naval warfare against the Russian naval fleet at their disposal, which is why high priority had to be given to developing sea denial capabilities and asymmetric weapon systems enabling Ukraine's forces to act in the maritime domain. Since the beginning of hostilities, Ukraine has also made massive use of different types of aerial and maritime drones. The *Bayraktar TB2* uncrewed aerial system (UAS) in particular was used quite frequently in the first months of the war. With the war ongoing, the use of uncrewed surface vehicles (USVs) has become more frequent. So by the summer of 2022, several smaller units of the Russian fleet had been reported lost after drone strikes in connection with the fight for Snake Island. So far, Russia's Black Sea Fleet has suffered severe damage from Ukraine's naval drone attacks, and Ukraine has succeeded in considerably restricting the Russian warships' freedom of operation. Numerous combat, landing and combat support ships have been damaged or even sunk.[6]

Although there have been reports about several Ukrainian sea drones being destroyed in attacks on Russian ships,[7] the USVs that did achieve effects against seagoing units of the Black Sea Fleet have caused considerable damage compared to the cost of

2 NATO 2023: 70–71.
3 Rosemann 2024: 8–13.
4 Different terms are used to describe warfare in the electromagnetic spectrum (EMS). Aside from the more specific term 'electromagnetic warfare', the term 'electronic warfare' is also in common use. In Russian military parlance, the term 'radioelectronic warfare' (*radioelektronnaja borba*) is used. For reasons of consistency, the terms 'electromagnetic warfare' and 'warfare in the electromagnetic spectrum' will be used in this paper.
5 The Bundeswehr's own use of sea drones – for instance in minehunting – has been discussed by others and is not part of the present analysis.
6 Reich 2022; Sutton 2022; Hagen 2023; Staalesen 2023.
7 Fenbert 2023; Militarnyi 2023; Alarabiya News 2024.

employing these assets.[8] Together with other factors such as missile strikes against Russian port and command and control infrastructure,[9] Russia's inability to adequately respond to this threat was a major reason why it had to withdraw its fleet from the western Black Sea. According to estimates from spring 2024, about one quarter or one third of Russia's Black Sea Fleet has been destroyed or disabled so far.[10]

Although Ukraine has been able to significantly weaken the Russian Black Sea Fleet over the past two and a half years, Russia's naval forces still have key capabilities that pose serious challenges to Ukraine. Aside from Russia's capability to use cruise missiles to engage land targets and the continued dominance of its submarine forces in the underwater (sub)domain, additional challenges are posed by the distinct capabilities of its armed forces to operate in the electromagnetic spectrum. Among other things, Russia's armed forces employ electronic countermeasures (ECM)[11] to contain the threat posed by Ukrainian drones. In addition, ECM are used in a wide variety of scenarios, for instance to disrupt telecommunication links, to deceive systems and sensors and to influence trajectories. To a considerable extent, warfare in the electromagnetic spectrum also takes place in the maritime domain. In the northwestern part of the Black Sea, for example, modern navigation systems depending on satellite navigation signals are being disrupted.[12] As both the war in Syria and the war in Ukraine have shown, electromagnetic warfare is one of the pronounced strengths of Russia's military.[13]

So far, Germany has paid particular attention to the way in which EW is being used in the war in Ukraine and, above all, to Russia's superiority in this discipline in connection with ground and air combat, e.g. in terms of force protection and air strikes. However, being able to achieve effects within and from the maritime domain against a peer competitor would be vital for the German Navy, too.[14] Such capabilities would include the spoofing of satellite signals,[15] the jamming of radar equipment, reconnaissance sensors, GPS-controlled missiles and ammunition and aerial and maritime drones, and also the preparation for missile strike scenarios such as those that have already unfolded in the war in Ukraine.[16]

8 Lefief 2024; Thorne 2024.
9 Fisher/Shevchenko 2023; Sutton 2023a; The Maritime Executive 2023.
10 Baker 2024; AP News 2024.
11 Electronic countermeasures are a part of electromagnetic warfare. Their aim is to either prevent the enemy from using the electromagnetic spectrum (e.g. radar or communication signals) by taking appropriate measures, or to cause enough disruptions to reduce the opponent's capability to use the EMS as much as possible. As J. C. Toomay points out, there are two types of ECM: The first one includes jamming and other active ECM, i.e. the targeted emission of energy in the frequency band of the received signal. The second one is passive ECM, i.e. the emission of various forms of spurious energy (Toomay 1989: 111–112).
12 Chiriac/Withington 2024; interview with a representative of an anonymous maritime interest group heavily affected by the war in Ukraine, conducted on 25 October 2023.
13 The Economist 2023; Tartachnyi 2024; Military Watch Magazine Editorial Staff 2024.
14 Krug 2023a.
15 'Spoofing' means sending a manipulated signal to a receiver to superimpose an authentic (satellite) signal. Spoofing is used to manipulate systems (e.g. platforms or weapons) that require signals for detection and control.
16 Tuzov 2024; Chiriac/Withington 2024; Tartachnyi 2024; Military Watch Magazine Editorial Staff 2024.

Challenges for the German Navy

In the ongoing war in Ukraine, changes in the character of warfare have become apparent. For the German Navy, these developments imply great challenges that need to be addressed in the near future. The aforementioned manifold possibilities of modern electromagnetic warfare go far beyond the traditional capability of radar jamming mostly used against active radar seekers in missile defence.[17] Moreover, reports about the war in Ukraine indicate that the electromagnetic spectrum has been used far more extensively than the frequency ranges of Germany's systems would allow.[18]

One lesson learned is that – as events in the maritime war zone in the Black Sea have shown – high-intensity wars require naval forces to have access to the full range of capabilities in the electromagnetic spectrum. Should Germany be required to participate in such a war in the future, the lack of sufficient capabilities in the EMS would lead to severe problems: German units would be significantly restricted in their conduct of operations. In this context, conceivable scenarios would include constraints regarding the communication and navigation of seagoing units, the inability to engage with an enemy on an equal footing as far as the use of ECM is concerned, and limited possibilities of achieving effects, for example, with the RBS15 Mk3 missiles that are used by German corvettes and that rely on GPS navigation.[19]

At this point, the adverse effects of several developments become apparent, especially regarding our armed forces' capability to fight in the electromagnetic spectrum. In order to counter new and disruptive technologies, it is necessary to develop new systems that are highly flexible when it comes to operating in the EMS. According to the U.S. Army's Positioning, Navigation and Timing project manager, procurement of such systems requires 'agile and adaptive acquisition processes'.[20] However, agility and flexibility is exactly what the Bundeswehr procurement system is lacking.[21]

Another problem is that decades of international crisis management (ICM) have taken their toll: in the scope of these activities, the operational requirements on the German fleet have been greatly reduced – especially those that would become relevant in a high-intensity war against a technologically strong enemy. However, given that regular processes – and thus changes – in the Bundeswehr are, as a rule, initiated and justified by means of statements of requirements, all system-immanent 'self-healing powers' have been more or less subdued.[22]

Finally, the topic of EW must also be considered when it comes to sea drone defence. One possible option is to employ electronic countermeasures to neutralise or disrupt USVs. According to Russian reports, ECM have already been used to repel attacks by Ukrainian USVs on Russian warships.[23] Irrespective of the veracity of Russia's statements, it must be noted that the use of ECM to disrupt data links to the MUS is an

17 Kopp 2014.
18 Withington 2023; Militarnyi 2024; Cazalet 2023; for publicly accessible information about parameters of German EW systems see, for instance, Muir 2007 and Krug 2023b.
19 Frank 2020.
20 PMPNT 2023: 1.
21 Vereinigung der Bayerischen Wirtschaft 2023; MDR 2023.
22 For a more detailed description of the connection between the identification of a capability gap and the establishment of functional requirements and procurement processes, see e.g. Bundeswehr 2024.
23 Waldmann 2023; Sutton 2023b; Pervyj Sevastopol'skij 2024.

effective engagement option, particularly with a view to semi-submersibles that are difficult to neutralise using hard kill options (i.e. physical destruction by kinetic effect).

This leads us to the second component of naval warfare in which the German Navy should urgently revise its capabilities: the threat posed by sea drones. Considering the high destruction potential of naval drones and the fact that they are relatively easy to procure and to use, and given their positive cost-effect relationship as a means to establish sea denial in naval warfare, sea drones – if widely used by Russia – are a potential threat to the North Atlantic Alliance's superior naval forces in the Baltic Sea.

The war in Ukraine has shown that the use of on-board weapons against USVs – particularly in reaction to the employment of drone swarms (saturation attacks) mainly against smaller units, as conducted by Ukraine – seems to have only very limited effects. Even though some Ukrainian drones were destroyed by Russian warships during these attacks, the attacking USV swarms caused severe damage to the less heavily armed warships of the Russian Black Sea Fleet.[24]

Depending on the design, USVs benefit from various advantages in the fight against manned seagoing units. These include their high speed as well as their enormous manoeuvrability and low detectability due to their small silhouette. Moreover, further developments in the field of MUS must be considered for the future. These could include, for example, semi-submersible naval drones and USVs that, on closing in on their target, transit to a fully submerged state (uncrewed underwater vessels – UUVs). Since August 2023 at the latest, Ukraine has begun testing a new offensive UUV named *Marichka*, and some companies have already developed concepts for combat operations with UUVs.[25]

In the best case, MUS are reconnoitred and engaged from the air and at the greatest possible distance from own ships/formations. According to reports, Russia has relatively successfully used combat helicopters to fight USV-role MUS.[26] On-board helicopters are used in various mission roles, including antisubmarine warfare, compilation of an operational picture and support in target marking in over-the-horizon targeting for subsequent engagement by the helicopter carrier.[27] Therefore, on-board helicopters are rarely available for use in an anti-USV role. The frigates of Germany's Flotilla 2 are equipped with SEA LYNX on-board helicopters. This helicopter type will soon reach the end of its service life and will be replaced by the SEA TIGER.[28] The German Navy will then have on-board helicopters that can not only be used as remote reconnaissance assets but that may also serve as 'fully-fledged anti-surface warfare helicopters' capable of engaging USVs with their heavy machine guns.[29] This aerial combat capability will not be equally available to the units of Flotilla 1, since they do not have on-board manned aircraft but depend on support from land-based aircraft. However, given the fact that these units are primarily earmarked for operational scenarios in marginal seas,

24 See, for example, Defense of Ukraine [Official Website of the Ministry of Defence of Ukraine] 2024.

25 Ignatova 2023; interview with an authoritative representative of the defence industry on 24 January 2024. For complementary information, see: Ozberg 2023 and BFBS Forces News 2023.

26 Novyj Sevastopol' 2023.

27 Over-the-horizon targeting encompasses target acquisition and, as a result, possible target engagement beyond the radar horizon and thus beyond the detection range of the own platform's sensor system.

28 Mergener 2020.

29 Ibid.

they would be particularly exposed to USV attacks. What results from this is the need to expand the capability spectrum of the units of Flotilla 1 and possibly to adapt Germany's naval war doctrine. In this context, the aforementioned option of combating MUS via electronic countermeasures can only be one element of the required capability build-up in the German Navy associated with the historic changes we are experiencing in these times.

Conclusions and Recommendations for Action

After decades of peace and low-intensity ICM operations, the number of units lost in the war in Ukraine has once again brought home the importance of being able to compensate for losses in high-intensity conflicts.

The German Navy has fully understood this connection and adapted its military procurement policy accordingly (more equipment means greater resilience). The increase in the number of naval warfare assets in the fleet's inventory, that, as planned in the *German Navy Objectives for 2035 and Beyond*, is to be realised by commissioning additional unmanned weapon systems such as the Large Unmanned Underwater Vehicle, the Future Combat Surface System and the Unmanned MCM System, is certainly a step in the right direction to meet this requirement.[30] However, considering the two topics addressed in this #GIDSstatement – EW and sea drone defence – a quantitative increase in Germany's naval assets alone will not suffice.

Given the current changes in character of warfare involving the use and denial of the electromagnetic spectrum, the Bundeswehr should in a first step urgently invest in the expansion of its naval capabilities in the field of electromagnetic warfare. Depending on the operational scenario, investments in the field of EW could also bring economic advantages in the long run, for instance if the employment of often very expensive hard kill effectors, such as certain air defence systems, could be reduced by using EW assets. In the short run, one solution could be to take commercially available solutions such as shoulder-based jammers aboard or to install jammers such as those already employed by other ministries in order to increase the EW capability of own units and at least mitigate the threat posed by UAS. Rainer Krug explains: 'The ability to achieve superiority in and dominate the spectrum is also often the key to successful military operations.'[31]

Finally, at ministerial level, a strategic armaments and industrial policy should be geared towards creating a favourable environment for German defence companies in order to create – where possible – a competitive situation between two to three of these companies on the market and thus improve the Bundeswehr's position as a customer. The example of Israel shows that this is possible for a small country, too.

It would also be advisable to expand German doctrines and capabilities with regard to sea drone defence. To effectively combat MUS, it is recommendable to establish a layered defence sensor/shooter network at ship and formation level, as has already been done in the scope of anti-ship missile defence (ASMD).[32] This requires appropriate

30 Bundeswehr 2023: 8, 10–11.

31 [Translated from the German original:] Krug 2023a.

32 In missile defence, layered defence describes a complex system of sensors and effectors ranging from long-range air defence – usually for formation air defence purposes – to close-range air defence of individual warships (self-protection). The 'last moment weapon' is a close-in weapon

sensors for target acquisition/tracking and effectors for target engagement over large distances as well as at close and very close range.

As the war in Ukraine has taught us, Ukrainian naval drone attacks on Russian warships were particularly fatal when the drones remained undetected for as long as possible, for example in the case of attacks conducted under reduced visibility, so that the Russian crews' response times were reduced to a minimum. Consequently, one important factor in naval drone defence is early and permanent reconnaissance and surveillance of the maritime environment, even at night, in order to be able to detect and track enemy naval drones at the greatest possible distance from one's own ship or formation. A particularly expedient option to counter the potential threat posed by sea drones to own units is to increase the number of airborne reconnaissance assets and weapons available to the Navy. In addition to the possibility to counteract sea drones far beyond the range of on-board weapons, another advantage of these assets is the fact that MUS can be engaged from the air at a better angle and thus more effectively. Hence, it is advisable to consider the acquisition of additional unmanned systems, such as drone helicopters or unmanned armed tiltwing aircraft, as requested by the U.S. Marine Corps[33], that are equipped with suitable effectors and capable of conducting sea surveillance as pickets. As H I Sutton mentions, units of the Russian naval fleet are testing quadcopter UAS to see if they have the potential to neutralise Ukrainian USVs when closing in on their target.[34] Many types of UAS are particularly suited for this purpose as they are able to maintain a long on-station time in the operating area. Particularly effective defence could be provided by establishing a strike-on-detection drone combat air patrol (CAP) over designated sea zones.

With regard to close-in defence of German warships for self-protection, it is advisable to take measures aimed at supporting the effects of on-board weapon systems and increasing the firepower and rate of fire, or at complementing these effects to cover engagement ranges that are difficult to reach with on-board weapons. Not least because of his own experience, former Russian Defence Minister Sergei Shoigu (2012 – 2024) requested the installation of additional large-calibre machine guns on Russian navy vessels when he visited the Black Sea Fleet in March 2024.[35] Eventually, the use of driftnets might also be an option, as it is a capability that the German navies used during World Wars I and II as well as during the Cold War – and one that is easily implemented.

The war in the Black Sea has shown that a country with a very rudimentary navy can successfully apply an asymmetric approach based to a significant extent on the use of MUS. In fact, this approach has enabled Ukraine to effectively wear down the Russian Black Sea Fleet, a fleet that is superior in many respects at the conventional level, and to successfully deny this fleet access to a marginal sea. Since it can be assumed that other actors will follow the example of Ukraine and make use of the various types of MUS – USVs/semi-submersibles/UUVs –, it is imperative to strengthen our armed forces' knowledge of these naval assets, to keep abreast of their ongoing further development and of the possibilities to counter them by conducting practical tests with demonstrators. We need to do so without delay.

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system. A well-coordinated, multi-layered defence complex increases the likelihood of effectively countering an incoming missile threat (cf. Navy Recognition 2018).

33 Odrich 2016.

34 Sutton 2023b.

35 The Moscow Times 2024.

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