SEABED SECURITY

UNDERSTANDING THE SEABED BATTLESPACE: INSIGHTS FROM CAPTAIN DR. SERDAR TOMBUL

THIS INTERVIEW DOES NOT REFLECT THE OPINIONS, POLICIES, VIEWS OF NATO OR THOSE INDIVIDUAL MGEOMETOC COE SPONSORING NATIONS.

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The seabed is no longer a distant or secondary concern. As undersea infrastructure grows in scale and strategic importance, so too does the need to better understand the environment in which it operates. From submarine operations to advanced acoustic research and NATO-level concept development, Captain Dr. Serdar Tombul brings a perspective grounded in both operational experience and technical expertise.

Ahead of Seabed Security 2026, he reflects on how environmental intelligence, evolving technologies, and closer international cooperation are reshaping how we approach the protection of critical underwater infrastructure.

Dr. Serdar Tombul, Captain, TUR N (OF-5)
Concept Development and Experimentation Branch Head
NATO Maritime GEOMETOC Centre of Excellence

Captain Dr. Serdar Tombul is a Turkish Navy officer specialising in submarine operations, underwater acoustics, and oceanography. After graduating from the Naval War College in 2001, he served as a submarine officer before completing a master's degree in Acoustic Engineering at the US Naval Postgraduate School, where he double majored in Electrical Engineering within the Undersea Warfare Department.

He later worked in acoustic research and national sonar projects, conducting LOFAR measurements for Turkish Navy ships and submarines. From 2012, he served as an oceanographer within the Office of Navigation, Hydrography and Oceanography, analysing GEOMETOC and climate data, producing military geographic products, and representing Türkiye in multiple NATO working groups.

He completed his PhD in 2022, focusing on underwater noise mapping and ship traffic density analysis in the Turkish Straits System.

In senior roles at Turkish Navy Headquarters, he directed research, sonar, underwater detection, and communication system modernisation projects. Since August 2025, he has served as Concept Development and Experimentation Branch Head at the NATO Maritime GEOMETOC Centre of Excellence, focusing on advancing operational concepts and technologies for the maritime domain.

1. You began your career as a submarine officer and later specialised in acoustic engineering and underwater warfare. How have these experiences influenced the way you now think about seabed security?

I began my career as a submarine officer on a diesel submarine, and that experience fundamentally shaped how I understand the underwater environment. When you operate in a submarine, you are enclosed in steel, hidden beneath the surface, operating in darkness and uncertainty. You are effectively blind. You do not see — you listen. Your awareness depends entirely on sound: detecting potential adversaries, but also monitoring civilian shipping traffic. Any vessel can pose a risk to an underwater platform.

All orientation underwater is noise-dependent.

Later, I specialised in underwater acoustic engineering at the Naval Postgraduate School in the United States, within the Undersea Warfare Department. This gave me a deeper theoretical understanding of the physics of underwater warfare — particularly how sound propagates, how detection works, and how the environment influences operations.

This combination of operational submarine experience and academic acoustic expertise shaped my current perspective on seabed security in two important ways.

First, underwater nothing is truly isolated. The water column, the seabed, the acoustic soundscape, and human activity all interact. Protecting critical infrastructure requires a systems perspective — you must understand the whole environment, not just individual assets.

Second, adversaries exploit complexity. Submariners are trained to use the environment — thermal layers, seabed topography, ambient noise — to avoid detection. Today's seabed threats mirror this behaviour: operating quietly, slowly, and at depth. Understanding submarine tactics helps us anticipate how unmanned underwater vehicles or other hostile systems might approach or attempt to tamper with critical infrastructure.

Our experience from manned submarine operations

can therefore be directly applied to understanding how unmanned underwater systems may behave — whether in our waters or in those of an adversary.

2. In your current role at the NATO Maritime GEOMETOC Centre of Excellence, how does environmental and ocean data help to protect critical underwater infrastructure?

At the NATO Maritime GEOMETOC Centre of Excellence, our mission is to ensure that environmental and oceanographic information becomes an operational advantage.

For seabed security, this means several things.

First, we predict how sound propagates under different environmental conditions. This enables more effective sonar surveillance and improves detection capability.

Second, we analyse seabed characteristics. Bottom composition influences how sensors should be placed, how cables or pipelines may be concealed or exposed, and how an intruder might approach underwater infrastructure.

Third, we map currents and water masses. This helps model likely routes for autonomous underwater vehicles or drifting objects such as mines, improving anomaly detection and predictive analysis.

Finally, we establish environmental baselines. By understanding normal acoustic and physical conditions, we can quickly identify deviations - new noise sources, physical disturbances, or acoustic shadows.

In essence, when we understand the environment, we reduce uncertainty. Reduced uncertainty allows us to detect small, slow, or covert threats at an earlier stage.

3. Your PhD focused on underwater noise and ship traffic in the Marmara Sea. How can noise monitoring and traffic analysis help us detect suspicious activity near seabed infrastructure?

My PhD focused on ambient noise in the Turkish Straits System - including the Istanbul Strait and the Çanakkale Strait - not only the Marmara Sea. This is a highly strategic region, both economically and militarily.

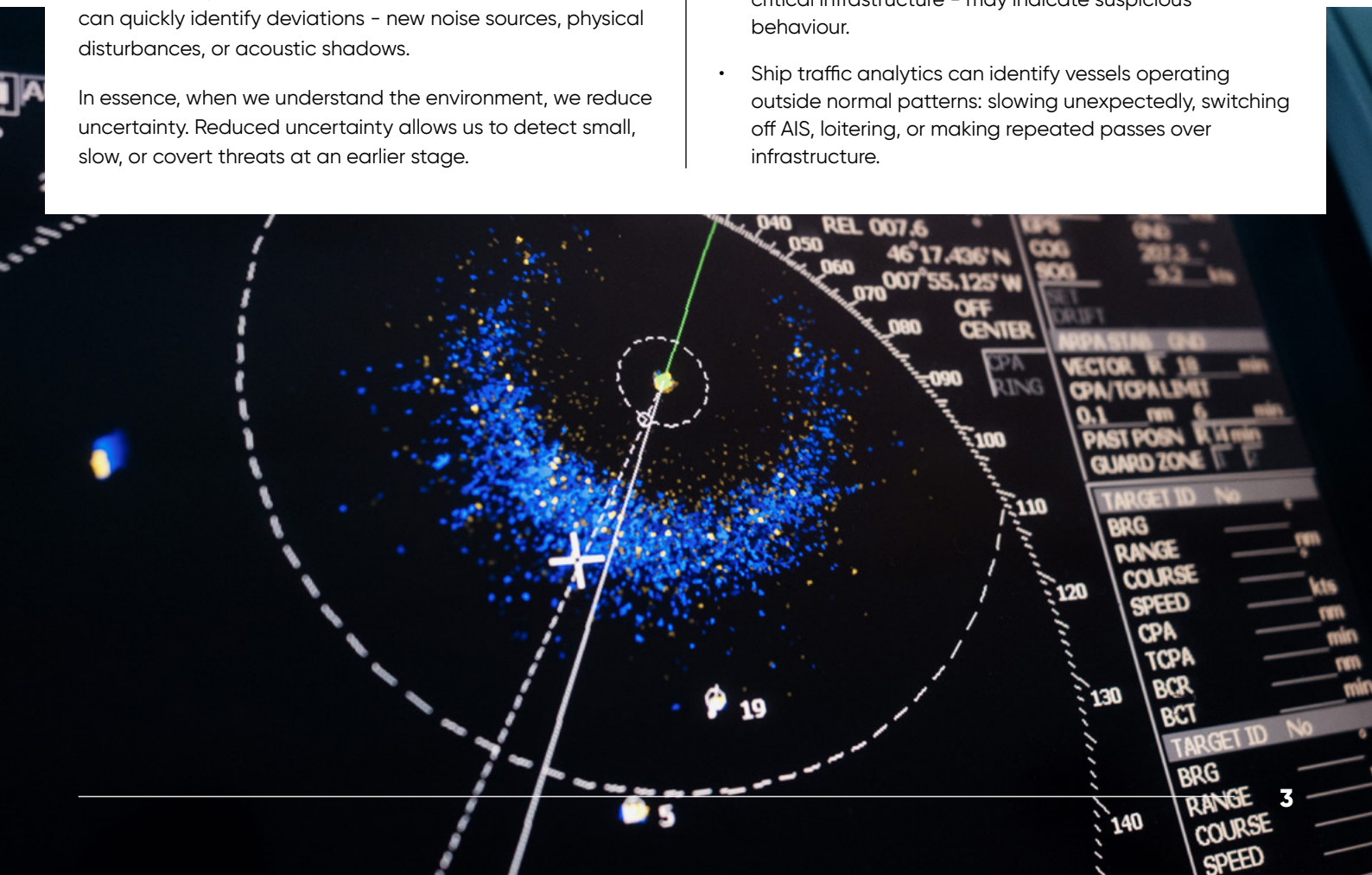
It is one of the most important maritime passages in the world for civilian shipping. It also has significant military relevance. For example, during the current conflict involving Russia, warships cannot freely pass between the Black Sea and the Mediterranean through the Turkish Straits. The region therefore holds considerable geopolitical importance.

Oceanographically, it is also unique. The upper and lower water columns have different current systems due to distinct physical properties of the connected seas. This creates complex acoustic conditions.

My research demonstrated how much information is embedded in the underwater soundscape. Noise monitoring becomes a powerful surveillance tool when combined with intelligent analysis.

For example:

- Acoustic anomalies - such as unusually quiet vessels, stationary noise sources, or repeated patterns near critical infrastructure - may indicate suspicious behaviour.
- Ship traffic analytics can identify vessels operating outside normal patterns: slowing unexpectedly, switching off AIS, loitering, or making repeated passes over infrastructure.



- Machine learning classification can distinguish between different acoustic signatures - for example, a fishing trawler, a diver support craft, an ROV, or an autonomous underwater vehicle.
- Long-term noise baselines allow detection of very small changes, which is especially useful if infrastructure is being tampered with gradually.

The sea is always producing noise. The key is to understand what is normal, so that we can immediately detect what is not.

This requires establishing baseline data first and continuously monitoring critical hotspots. That is why such studies are especially important in strategic passages like the Turkish Straits, where economic and military interests intersect.

4. In your view, how has the threat to critical undersea infrastructure changed in recent years?

The threat landscape has changed significantly.

State and non-state actors now recognise seabed infrastructure as a strategic vulnerability, not just a military domain.

Technologies enabling deep-sea access have become more affordable and widely available - including commercial autonomous underwater vehicles capable of conducting complex missions.

Hybrid threats have increased. Attribution is often deliberately ambiguous, and actions are covert or deniable.

At the same time, infrastructure has expanded and become more interconnected. Energy grids, communication cables, offshore platforms, and data links are deeply integrated. This increases both vulnerability and complexity of protection.

Where the primary concern in the past was accidental damage or isolated sabotage, today we face deliberate, systematic, and technologically capable actors probing underwater networks.

5. You have managed projects involving sonar, underwater detection, and communication systems. Which technologies do you think will be most important for seabed security in the future?

When we understand the environment, we can develop the right tools. Traditional systems remain valuable, but as adversary capabilities evolve, our detection systems must also evolve. This is a continuous process.

Several technologies will be particularly important:

- Persistent seabed sensor networks with low power consumption and reliable network communication.
- Long-endurance autonomous underwater vehicles for patrol and inspection missions.
- AI-enabled acoustic analysis for anomaly detection and autonomous classification. Artificial intelligence is developing rapidly and must be integrated into our analytical processes.
- Hybrid communication networks combining acoustic, optical, and RF links to ensure resilience. We cannot rely on a single communication method. Adversaries may attempt denial techniques - such as GNSS disruption or communication blocking. A hybrid approach ensures connectivity in contested environments.
- Digital twins of the seafloor to enable predictive modelling of disturbances and intrusions.
- Non-acoustic detection methods - including magnetic, chemical, and pressure-based sensors - to complement traditional sonar.

The future will be defined by integration: multi-sensor networks, multi-domain data fusion, and autonomous decision-support systems.

6. As Head of Concept Development and Experimentation, what does this work involve in practice? How do you test and develop new ideas for protecting the seabed?

I have been in this role for six months, so I am still in a learning phase. However, concept development and experimentation is fundamentally about moving ideas from theory to operational reality.

In practice, this involves:

- Identifying capability gaps based on operational needs.
- Designing experiments, trials, and modelling campaigns to explore potential solutions.
- Collaborating with navies, academia, and industry to prototype technologies.
- Conducting validation exercises, sometimes in real-world conditions.
- Translating experimental results into doctrine, requirements, or capability proposals.

For seabed security, this might involve testing new autonomous underwater vehicle swarming behaviours, evaluating optimal sensor placement strategies, or improving environmental models to support surveillance.

For example, I am currently working on 4D oceanographic modelling. We are processing large datasets, and I am using AI-assisted coding and prompt engineering to develop improved interpolation models and enhanced data visualisation.

For an upcoming exercise, I plan to implement newly developed software to visualise and process our collected data more effectively.

7. You have worked in many NATO groups and international teams. What are the main challenges when different nations work together to protect critical underwater infrastructure?

There are several challenges.

First, nations have different priorities. Some emphasise energy security, others communications, others defence.

Second, data-sharing limitations are significant - particularly regarding sensitive acoustic or infrastructure data. For example, acoustic signatures of naval vessels are highly classified. Within NATO, we may share formats and methodologies for data exchange, but not the raw acoustic data itself.

Third, technological maturity varies. Nations operate different classes of sensors, platforms, and data standards.

Fourth, there are legal and jurisdictional complexities - especially in Exclusive Economic Zones or shared maritime spaces.

Finally, coordination between civilian and military authorities differs significantly between countries.

Despite these challenges, collaboration is essential. Critical infrastructure such as data cables and pipelines is inherently transnational. No single nation can protect it alone.

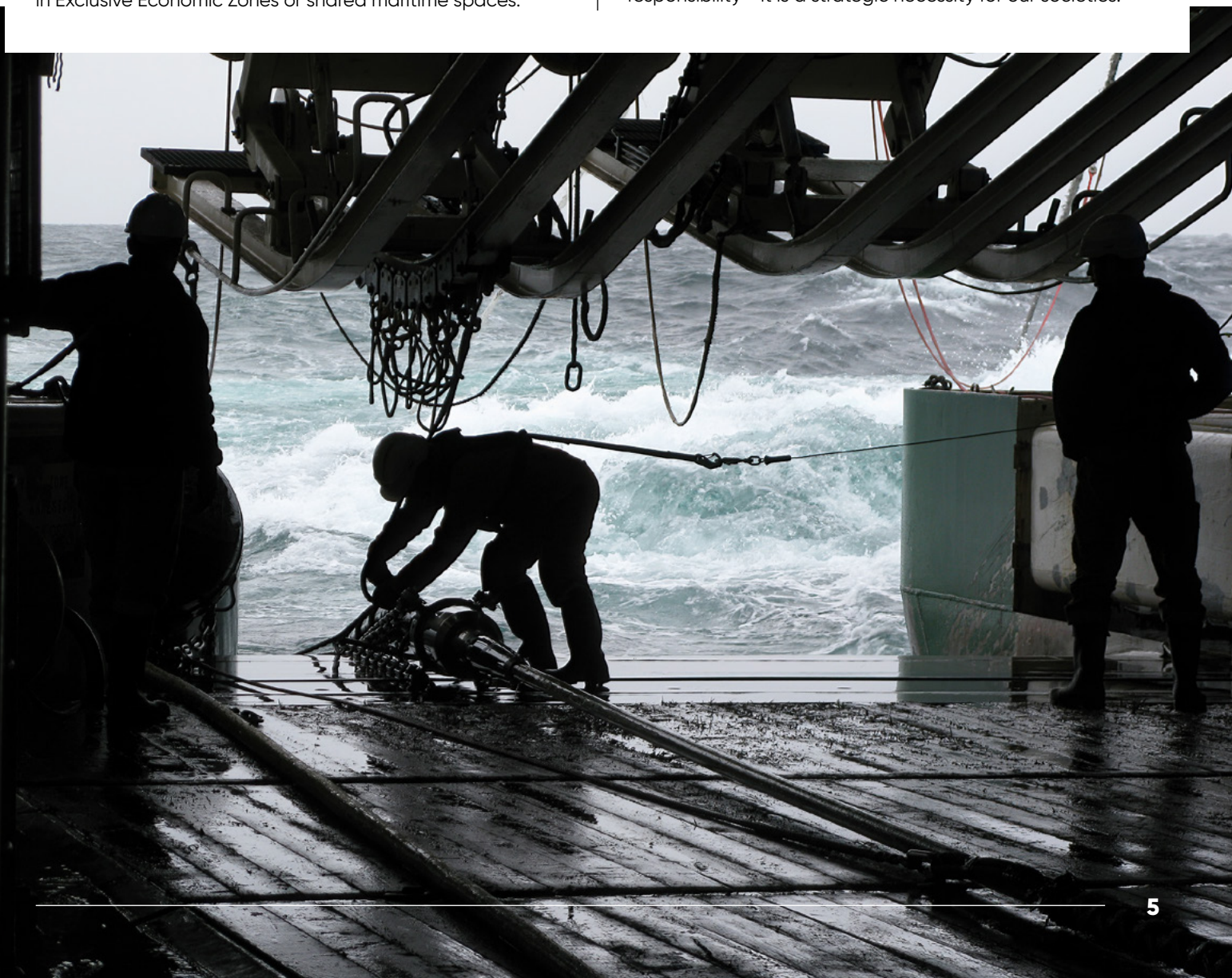
8. At Seabed Security 2026, experts will discuss threats and new defence solutions. What key message would you like to share with the audience at the conference?

Seabed security is no longer a niche discipline. It is a core element of national resilience and collective defence.

To protect the seabed effectively, we must integrate environmental knowledge, advanced technology, and multinational cooperation.

The adversary is becoming more covert, more capable, and more creative. Our response must be faster, smarter, and more unified.

The seabed underpins our digital systems, energy networks, and economic stability. Protecting it is not only a military responsibility - it is a strategic necessity for our societies.



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13 - 14 October 2026
Design Hotel, Tróia, Portugal

Join us at Seabed Security 2026

As activity across the seabed accelerates and critical undersea infrastructure becomes increasingly exposed to evolving threats, the need for coordinated, forward-looking solutions has never been greater.

Join senior military leaders, government officials, and industry innovators at Seabed Security 2026 (13–14 October 2026, Design Hotel, Tróia, Portugal) to shape the future of critical underwater infrastructure protection. Engage in high-level discussions on the current threat landscape, explore emerging strategies for seabed operations, and examine the cutting-edge technologies redefining detection, surveillance, and defence beneath the surface.

This is your opportunity to collaborate with key stakeholders from across the undersea community, exchange operational insight, and contribute to strengthening the resilience and security of the systems that underpin global energy, communications, and defence.

Secure your place at Seabed Security 2026 and be part of the conversation defining how we protect the seabed in an era of increasing activity and strategic competition.

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