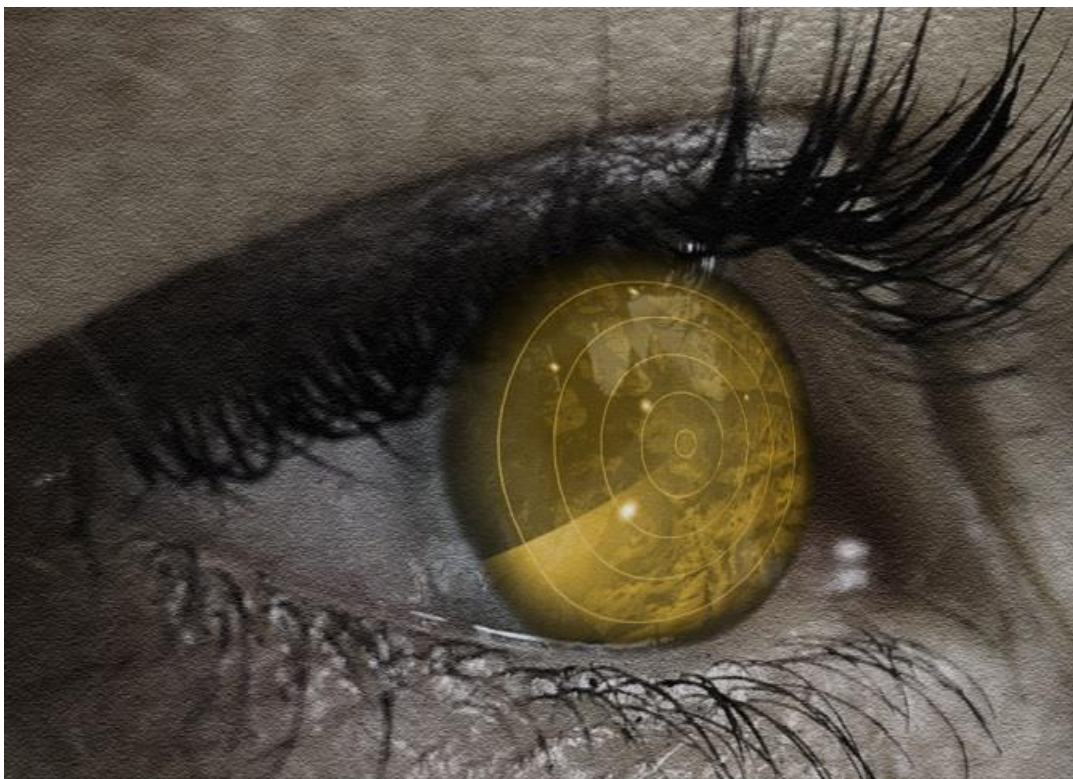Centre of Excellence
for
Operations in Confined and Shallow Waters

Prospective Operations in Confined and Shallow Waters

Study Paper

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Foreword

Confined and Shallow Waters provide military planners and operators today with an ever expanding challenge. Current and future advancements, not only in technology but also in warfare tactics and players, apply constant manipulation to this already intrinsically complex environment.

This paper, in an effort to further inform and prepare its readers for operations in confined and shallow waters, defines the battlespace, current threat trends, and expands on future challenges we can expect to face in this very specific littoral theatre of operations. It further presses upon the importance of confined and shallow waters which remain the most vital (economically and politically) and frequently trafficked maritime operating areas. Therefore, its scope is not limited to NATO / EU areas of interest, but further seeking to provide a global perspective.

In conclusion, weighing the current challenges not only of the natural environment but also of contemporary war fighting and following a logical trend for advancement, it is clear that NATO and the navies wishing to remain dominant players also in confined and shallow waters must constantly adapt and evolve to remain apace. Failing to do so will open the floodgates to countless opportunists who would like nothing more than to threaten economic stability, government power, and the inherent rights of seafaring merchant groups and individuals.

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Release

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*"Change is the law of life. And those who look only to
the past or the present are certain to miss the future."*

John F. Kennedy

Executive Summary

This study paper provides a future vision of prospective operations in the specific environment of Confined and Shallow Waters [CSW] serving as a general orientation for CSW-related matters as well as a basis for respective future-oriented work. It is regarded as a living document in order to assure that its content will keep pace with current developments related to operations in CSW as well as any corresponding progression in warfare. Therefore, an update and review by staff members of COE CSW will be accomplished regularly.

The Relevance of Confined and Shallow Waters

Approximately half of the world's population lives within 200 kilometres of a coastline, by 2025 their number is likely to double. 90% of the world's commerce is seaborne and 75% of that trade passes through at least one narrow, and thus vulnerable, strait. The vast majority of the Sea Lines of Communication [SLOCs], choke points, ports and other infrastructure are located in CSW and may cause severe disruptions by being exposed to illegal actors like terrorists, pirates, or organised criminals. At the same time, the coastal areas are in particular vulnerable to natural disasters demanding complicated relief and crisis management efforts. It is, therefore, very obvious that special attention must be given to the CSW-environment. It remains the common interface of manifold legal, political, and economic interests and also maintains social and institutional implications.

A Common Understanding

Confined and Shallow Waters are to be regarded as a very particular theatre of operations where the courses of action for maritime forces are limited due to factors such as shallow waters (with a depth less than 200m), narrow straits, jagged and rugged coastlines, archipelago-like environments, tidal areas as well as extensive flats and shoals, rivers and estuaries. Furthermore, CSW also include the landward coastal areas where sensors, weapon systems, and logistics can be deployed that may influence or impede action at sea. As an operational environment, it encompasses the maritime, air, land, space, and cyber domains as well as all associated opposing, friendly, and neutral systems (political, military, economic, social, informational, infrastructure, legal, and others). Therefore, CSW is to be regarded as a very specific operational environment with a broad variety of actors, activities, risks, threats, factors and particularities which considerably affect the conduct of military operations.

CSW pose a significant challenge to military planners and commanders. However, the area should be viewed not only as an 'arena of risks and limitations' but also as a 'bouquet of opportunities' that may be exploited to one's own advantage. On the bottom line, CSW should be perceived as follows:

> *"CSW is a cramped, congested and contested operational environment constituting an extremely complex thus challenging littoral joint battlespace which affects the freedom of movement and action by specific geographical and geophysical factors as well as manifold threats and risks. On the other side, CSW also offers a broad range of possibilities and opportunities for military operations."*

Future Trends and Implications

Looking at potential drivers shaping future trends and anticipating their implications provides a sound basis for a visionary assessment of relevant factors influencing the CSW environment and the military operations within.

Human Theme

Cities will accommodate 65% of the world's population by 2040. The majority of these concentrated urban clusters will be situated in the vicinity of or right on the coast in littoral areas and thus in proximity to CSW. Growing urbanisation will spur economic growth but could put new strains on food and water supplies. Shortages in vital resources, failed infrastructure, increased likelihood of infectious diseases, and income disparities could result in dissatisfaction and rising criminality up to civil unrest in urban areas.

Human networks are expanding at an exponential rate. While they bear the potential to create enormous benefits, their advancement generally evolves ungoverned and chaotic. Therefore, negative tendencies are likely to occur especially as human networking has already become a medium for transnational crime and unbounded intelligence gathering and sharing. This precarious trend – being a form of (asymmetric) cyber threat – is likely to become increasingly complex, influential, and dangerous in the future.

Political Theme

The world is becoming increasingly interconnected and polycentric. The exponential increase of information technology and social media enables dispersed individuals to act as an effective, organised group within a network. At the same time, a more fragmented international system, an increased resource competition, and spillovers from regional conflicts may increase the potential for interstate conflicts.

As power becomes even more diffused than today, a growing number of diverse state and non-state actors will play important roles and will attempt to shape the outcomes of political, social, economic, and environmental issues. These challenges to the state-centric model will increase the overall complexity of military actions. Naval forces conducting operations CSW should have comprehensive situational awareness and advanced knowledge to understand the role and authorities of actors to be encountered, the structure of human networks, and the ability to assess potential threats in a hostile environment.

Technology Theme

The accelerating cycles of technologic innovation, along with the fusion of existing and future technologies, will fuel technologic changes and the need for rapid adaptation in the future. Past wars and conflicts have shown that changes in technology had significant impact on how battles were fought. Strategy and tactics are considerably influenced by the availability and consequent employment of new technologies. Miniaturisation up to nanotechnology, automation through to robotics, artificial intelligence, bionics, advanced communications and IT-technologies are simple but illustrative examples showing both the obviously huge potential that technological progress is bringing as well as its challenging effects. The consequent utilisation of new technologies is hardly anywhere else of such vital importance than for operations in CSW. It opens ways to counter the threats or to mitigate risks and, at the same time, to best exploit its opportunities.

Economics and Resources Theme

The contrasting growth rates of economies are exacerbating global imbalances and straining governments and the international system. The rising economies will solidify their position and expand their strength, being regarded as safer places for investment and growth. This will lead to a global maritime trade boom, which will further increase the significance of the major international shipping routes running through CSW as the vital connection between (major) ports as well as (mega-) cities.

Demand for food, water, and energy will grow significantly owing to an increase in the global population and the consumption patterns of an expanding middle class. Climate change will worsen the outlook for the availability of these critical resources. The rising nutritional demand remains a vital issue to mankind as starvation and malnutrition are capital drivers for social unrest, riots, and revolts easily creating areas with reduced governance up to failed states. Therefore, the relevance of the maritime environment, especially of the EEZs and sea beds, for world resource supplies will further increase.

Environment Theme

Empirical evidence alone – without reference to climate models – indicates that a general warming trend is affecting weather and ecosystems causing increasing impacts to humans. The frequency of extreme weather events – floods, droughts, tornadoes, glacial lake outbreaks, extreme coastal high-water levels, heat waves, etc. – will further increase during the next decades. Coastal areas with mega-cities are extremely vulnerable to the climate change and will be strongly affected. An increased need to deliver humanitarian aid to the afflicted areas is expected.

Furthermore, global warming is causing the ice to melt at the poles, improving access to the Arctic as well as Antarctica and will potentially allow for growing exploitation of natural resources in previously inaccessible regions. From the geographical point of view, a new focus area will arise in the Arctic environment that may be regarded as 'confined' and in parts of the passages also as 'shallow'. Intensified human activities in the Arctic and Antarctica will raise many issues. However resource exploration and exploitation may not easily be governed especially in those regions and rather trigger a danger of enforcing economic or political interests.

A Battlespace of Rising Complexity

As part of the transition zone interfacing land and sea, CSW are at the very heart of that sphere where all military domains interrelate with the largest share in 'jointness'. Without question, the geographical environment of CSW is very challenging, which creates manifold natural and manmade obstacles for military operations. Already, and expected to increase in the future, CSW are heavily trafficked areas. In addition to the confusing terrain and the multitude of contacts, artificial islands and critical superstructures and other exploration platforms will increasingly exert a tremendous influence on operations in CSW and consequently further enhance the already challenging complexity of this battlespace.

The rapid technological progress has facilitated the acceleration of information technology taking a key role in today's operational area. This has, in turn, made cyberspace

an increasingly crucial aspect within the battlespace. Consequently, new notions like cyber warfare come more and more to the foreground. This additional factor will increase the level of complexity and ambiguity in the operational space, affecting especially Maritime Situational Awareness [MSA]. Furthermore, the battlespace in CSW is heavily influenced by densely urbanised areas. These are melting pots where social, economic, and political interests easily come into conflict. Coastal mega-cities will especially complicate and greatly challenge the combat missions as well as political, social, and economic landscape in the future.

Advanced Warfare

Innovative technologies such as artificial intelligence, smart networks, advanced computing, automation, miniaturisation, nanotechnology, robotics, bionics, additive manufacturing, and advanced ship-building technologies are to be assessed with regard to their potential to support operational demands in CSW. These technologies foster a leading technical edge, in particular facilitating advancements of capabilities/features required especially for operations in CSW like fully-automated (unmanned) platforms, long-endurance (loitering) systems, advanced onboard as well as remote sensors and effectors, sophisticated deception systems along with reduced detectability or improved stability/ collapse resistance and enhanced (self-)sustainment.

Operations in CSW remain to encompass all military dimensions (maritime, air, land, space, and cyber). Emphasis will increasingly lie in joint and combined efforts, generally focusing on the effective whole and less on unilateral national approaches or single services. Interoperability and joint operations will increasingly be a prerequisite for success in CSW.

An 'all-in-one solution' suitable for every purpose and every complex requirement is an unattainable goal. For instance, aiming at a practical all-round setup providing required CSW capabilities on the smallest possible platform, being at the same time world-wide deployable, sustainable, and fully integrated in all operational networks, poses an inexplicable conflict of objectives. This dilemma can either be mitigated by abandoning high-level objectives and making compromises or it can be countered by innovative solutions such as an overall systemic approach. The latter combines autonomous devices for basic tasks with smaller platforms for specific purposes, mounting respective modules that allow flexible adjustments to the operational demands. Larger 'mother assets' round out this approach and ensure world-wide deployability, superb sustainability, on-site swap of modules, as well as comprehensive execution of command and control.

Main Parameters for Prospective Operations in CSW

Incompatible political, social, and cultural (including religious convictions) systems, as well as a mutual desire for conquering economic interests, bear an inherent and enduring potential for conflicts involving force of arms. The age of global economy inevitably implies the emergence of related risks and threats multiplied by the extreme complexities of the CSW environment, which remains to be a vital sphere for mankind and for access to most countries in the world.

Potential targets in CSW are likely to be the maritime trade, critical maritime offshore and coastal infrastructure, facilities and installations (such as wind power plants, oil rigs, sea cables or ports' navigation systems) and other technological equipment.

Future conflicts in CSW will be characterised by short notice, rapid escalation, limited duration, and high intensity leading to increased mortality as well as danger of collateral damage; all of which will be taking place simultaneously or consecutively conducted in the way of 'conventional' war-fighting. Operations below the threshold of war, such as constabulary and humanitarian missions aiming at supporting stability in concert with civilian organisations and entities, should also be expected to be conducted in CSW.

Future Operational Consequences

Operations in CSW are affected by all military domains and have an intimate relationship with the information space. This includes associated adversary, friendly, and neutral systems which are relevant to this specific environment. The diverse conditions and circumstances are to be considered upon the employment of capabilities and thus bear on the decisions of both the commanders and responsible planners. Understanding the full spectrum of consequences the CSW generates has always included a perspective that is broader than just taking into account the military forces of an adversary.

It is to be assumed that in the future many parallel missions are to be conducted simultaneously and not in a linear way, as in the past. This upcoming multi-layered and multi-dimensional operating environment demands specific approaches, capable of providing appropriate choices and courses of action, focusing primarily on the required effects and less on available means. This also demands timely prepositioning or at least a very rapid deployment and extensive (self-) sustainability as well as fully networked structures ensuring an adequate access to relevant information at all levels.

1. Introduction

1.1. Purpose

The purpose of this study paper is to provide a future vision of prospective operations in the specific environment of Confined and Shallow Waters [CSW] serving as a general orientation for CSW-related matters as well as a basis for respective future-oriented work.

1.2. Character

This work has been produced as, and shall be regarded as, a living document in order to assure that its content will keep pace with current developments related to operations in CSW as well as any corresponding progression in warfare. Therefore, an update and review by staff members of COE CSW will be accomplished regularly to keep it "up to date". Also any kind of external suggestions or comments are welcome.

1.3. Aims

The study shall be used within COE CSW as a basic document to familiarise personnel with the operational environment of CSW and its particularities as well as related future trends and challenges. Furthermore, it may be utilised as a reference for respective projects or serve as a foundation for the analysis of future capability requirements[1].

Not claiming to be a scientific research or a forecast of future developments, which may cause impacts on operations in CSW, this paper provides ideas on likely advancements that may have direct implications on military operations in CSW.

1.4. Scope

This paper provides a holistic and consolidated view on prospective operations in CSW. The time horizon comprises a mid- to long-term perspective (up to 20 years) on developments affecting operations in CSW. The scope covers command levels ranging from tactical to strategic; however the main focus is on the operational level.

To concentrate on essential trends, drivers, and advancements three scenarios were developed and utilised which served as samples for future engagements in the CSW, including new technologies and relevant threats and actors.[2]

The coherence of the document shall be ensured by its structure. The introduction describes the purpose, character, and aim of this study. Part 1 provides a short historical background and covers relevant methodological aspects. Part 2 describes the current role of CSW in maritime and joint operations, illuminating its particularities and importance not only for the military community but also for other relevant fields of interest. Essentially based on NATO's Strategic Foresight Analysis, Part 3 presents relevant trends and drivers for future developments of military and naval operations in the CSW-environment. Part 4 perpetuates the current role of CSW (Part 2) into the anticipated future CSW-environment (Part 3) in order to draw conclusions on future demands and challenges as well as their operational consequences. Finally, the findings are summarised and an outlook on further research of this topic is provided in Part 5.

1.5. Historical Outline

To illustrate the significance of coastal waters, basically comprising CSW, a brief historical account may be helpful. When mankind first began to sail the seas, for many millennia the maritime operational space was limited to the coastal environment. Only a few centuries ago, after the exploration of the high seas, has the maritime operational field of action been expanded to cover the entire water space. It should be noted that coastal waters remain of critical importance despite a shifting focus to deeper waters. Not only for the military, but also for the political, economic, and scientific fields, confined and shallow waters are of manifold interest.

Tracing back in history, numerous famous and decisive naval engagements have been fought in coastal areas as well as narrow geography and shallow waters. A well-known example is the Battle of Salamis in 480 B.C., during which the fleet of the Greek city-states alliance defeated an overwhelmingly superior Persian fleet. Other examples are the naval battles of the 17th to early 19th century, often referred to as the "Golden Age of Sail". The Anglo-Dutch Wars, the struggle for the American and West Indian Colonies, and the period of the Revolutionary and Napoleonic Wars lend credence and illustrate our claim.

A majority of the naval engagements during World War I were fought in or near coastal waters. Specific examples include battles in the Baltic Sea, the North Sea, the English Channel, the Mediterranean Sea, and the Black Sea. The control of narrow seas, and especially chokepoints, was of critical importance to the Entente as well as to the Central Powers.

In World War II, most of the world's coastal areas and marginal seas, including all seas adjacent to Europe, the Caribbean and the Southern Pacific, formed the battlespace for numerous, not just naval but increasingly joint, encounters. It was not until after the outbreak of war that the commanders ashore realised the importance of controlling the adjacent sea space while campaigning ashore.

After NATO was established in 1949 one of its fundamental roles was to act as a powerful deterrent against military aggression, being capable of fighting both in the open oceans and the littorals.

With the end of the Cold War in the early 1990's, the Alliance witnessed the emergence of new threats as well as the resurgence of old but familiar ones. In response to the significant changes to the security, NATO began to assume an increasingly proactive role within the international community. With the fall of the Soviet Union, the relative certainty of Cold War times was replaced by uncertainty and unpredictable challenges in a rapidly changing environment. Consequently, the strategic orientation was adapted from containment of the Soviet Union by offensive sea control and combative pursuit of the decisive battle, to expeditionary warfare and power projection. This was also a strategic shift from the high seas to littoral operations.

As a matter of fact naval forces and aircraft have been employed in coastal waters on numerous occasions since the Korean War (1953). Most notably during the Cuban Missile Crisis (1962), the Vietnam War (1965-75), the Arab-Israeli conflicts (1956, 1967 and 1973),

the Iran-Iraq War (1980-1988), the Gulf War (1990-1991), the Balkans conflict (1991-1995), the Crisis in the Persian Gulf (1998), and just recently in Libya (2011).

NATO's Allied Maritime Strategy [AMS], published in 2011, serves as a reference into questions of new emerging threats, challenges, and potential actors. Conclusively, a gradual shift from conventional adversaries, classical warfare, and high seas to irregular warfare, non-state actors, rogue states, and the littorals has taken place, thus shaping the security environment in an additive manner. The Ukraine crisis since 2014 does not reverse this development, but rather compels the perspective of regular forces to be further broadened. In fact, such forces are no longer only employed in conventional ways, but may also very effectively conduct hybrid warfare.

There is no doubt that in most future conflicts, regardless of scope and purpose, coastal waters will remain the major operating area of naval and especially joint actions. The Alliance must therefore continue to have the full spectrum of naval capabilities at its disposal to counter any symmetric or asymmetric threats and risks in blue water and also littoral regions.

1.6. Working Method and Main References

This study is the result of an iterative process, where the basic approach, outline, and rough content has been subsequently refined by discussing results of individual brainstorming and frequent review of written drafts. This method offered the possibility to work on Parts 1 to 3 in parallel. The essences of this work – the derivation of Future Demands and Challenges on Operations in Confined and Shallow Waters (Part 4) and of course also the Summary – had to be developed subsequently.

The first draft was presented and discussed in a workshop involving COE CSW staff members, representatives of Headquarters MARCOM, as well as some of the COE CSW participating nations. The draft has been further matured through reviews by the core team, COE CSW experts, and finally by NATO maritime entities and COE CSW participating nations.

The complexity of the topic demanded a thorough analysis and use of a broad variety of documents as well as articles and publications from military and non-military descent. Especially relevant NATO publications, such as the Allied Maritime Strategy (posing the base- and additionally the guideline for all thoughts about future NATO's maritime interests and engagements), the Long Term Capabilities Requirements Study, the Strategic Foresight Analysis and the Technology Trend Survey paper, were vital in the development stages of this study. Also several national doctrines and publications have been utilised, especially the United States Marine Corps Amphibious Operations in the 21st Century paper, the United States Naval Operations Concept 2010, the Royal Navy's Future Navy Vision, and United Kingdom's Global Strategic Trends study. Of course, academic literature has also been consulted, e.g. the Strategic Trends paper edited by the Centre of Security Studies of the Eidgenössische Technische Hochschule in Zurich, the Sandfire Maritime Surveillance Analysis, or Milan Vego's Operational Warfare at Sea.

2.   Relevance and Particularities of Confined and Shallow Waters

2.1.   Definitions

In principle, the existing notions of CSW share many relevant characteristics. However, there always remain some distinct deviations that can be owed to different conceptual approaches or varying warfare specifics. Based on the available definitions, some samples are briefly outlined below. This, not necessarily concordant, terminology is to be consolidated to an adequately consistent, common understanding of CSW which may promote innovative approaches through a broader notion.

- COE CSW Operational Memorandum of Understanding [MoU][3]

  Confined and Shallow Waters

  "Littoral areas of operation where the courses of action of both friendly and opposing forces are limited, at least due to some of the following factors: shallow waters, narrow straits, jagged and rugged coastlines, archipelago-like environments with small islands, tidal areas and extensive flats and shoals, often changing in size and shape under the influence of currents and/or weather conditions. It also includes those coastal areas from which hostile forces may be able to act against own forces."

- Milan Vego (Naval Strategy and Operations in Narrow Seas)[4]

  Confined Waters

  "… are those bodies of water, which, owing to their width and depth, constrict the manoeuvring of surface ships and submersibles and in some cases also limit the employment of shipboards sensors and weapons. In general, they encompass the waters of archipelagoes, straits, channels, narrows, sounds and artificial canals."

  Shallow Waters

  "… are those waters wherein wind-generated waves travel in less than one half of their length, and are defined as the marginal or inland extension of ocean having prevailing depths of under 600 feet (183 m). In the hypsometric[5] definition of the term, 'shallow waters' encompass coastal and inshore waters less than 100 Fathoms (183 m) deep. In acoustic terms 'shallow water' exists whenever the propagation of underwater sound is characterised by numerous encounters with both the sea surface and the sea bottom. In some cases a body of water could be considered hypsometrically shallow but 'deep' in respect of the propagation of underwater sound."

- AAP-6 (NATO Glossary of Terms and Definitions)[6]

  Shallow Waters

  "Water having a depth between 10 meters and 200 meters"

  Very Shallow Waters [VSW][7]

  "Water having a depth less than 10 meters"

The terms 'Confined' and 'Shallow Waters' are also mentioned in a number of NATO tactical publications; however all of which are basically reflecting the limitations posed by this environment related to the specific warfare area.

Taking all the above definitions into consideration, it is evident that CSW pose various operational, as well as navigational, restrictions due to geographic, oceanographic, hydrographic and meteorological effects. Although these converging views blind out any operational prospects, they are to be regarded as relevant aspects that shape the basis for further consideration aimed to provide a more comprehensive CSW perspective.

2.2. A Vital Interface

Oceans should not be regarded as having a separating effect; on the contrary they connect nations globally. In this sense, the oceans foster an interdependent network of economic, financial, social and political relationships. The statistics are compelling: about half of the world's population lives within 200 kilometres of a coastline, by 2025 their number is likely to double[8]; 70% of our planet is covered by water; and 90% of the world's commerce is seaborne. 75% of that trade passes through narrow, and thus vulnerable, straits. Hence, the maritime environment includes Sea-Lines of Communication [SLOCs], choke points, ports and other infrastructure such as pipelines, oil and natural gas platforms or trans-oceanic telecommunications cables[9]. The vast majority of these routes and installations pass through or are located in CSW.

Based on the global, regional, and local operations of international, national, commercial, as well as institutional stakeholders acting in the region, CSW are priority areas of interest linking the high seas with the coasts and its hinterland. Seaports are the hubs of global transportation routes where all merchant shipping operations start and end. Even trans-oceanic traffic is partially conducted through narrow straits and passages leading to seaports.

At such choke points, any maritime endeavour is subject to the risk of being easily hampered or even disrupted. Natural resources (e.g. oil, gas, fishing grounds, etc.) within the Exclusive Economic Zones [EEZ] are of great national as well as economic interest and bear a potential source for tensions and conflicts. The borderlines of international waters or territorial waters are often intricate, uncharted, or disputed.

Moreover, remote areas with reduced or even no governmental authority may cause severe difficulties by attracting illegal actors like terrorists, pirates, or organised criminals. Generally, CSW provide the principal environment for smuggling, proliferation of weapons, illegal migration, and human or drug trafficking.

At the same time, the coastal areas are in particular vulnerable to natural disasters demanding complicated relief and crisis management efforts. It is, therefore, very obvious that particular attention must be paid to the CSW-environment. It remains the common interface of manifold legal, political, and economic interests and also maintains social and institutional implications.
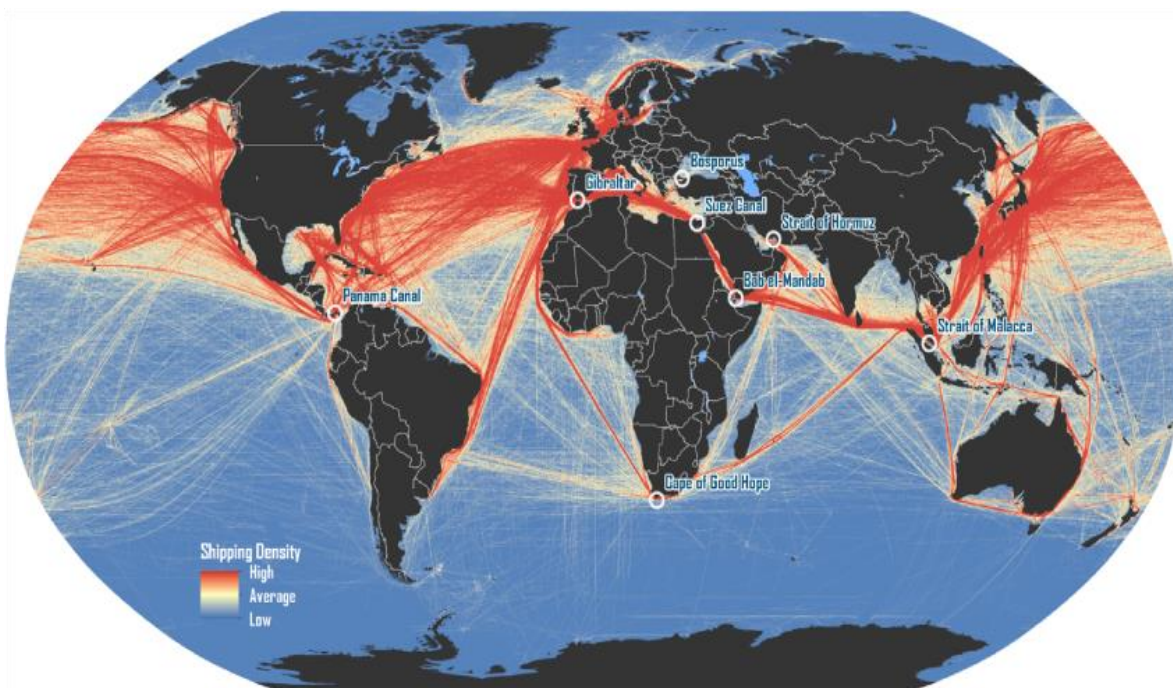
Global Shipping Routes – Density and Choke Points

Source: *Shipping density data adapted from National Center for Ecological Analysis and Synthesis, A Global Map of Human Impacts to Marine Ecosystems.*

Globalisation, technological advances, and the emergence of new, strong commercial players have resulted in a continuous and rapid growth of global trade. Maritime shipping is the cornerstone of global trade and the predominant means of goods transportation. Consequently, it is not surprising that the first decade of the 21st century saw an unprecedented transformation in global maritime trade[10]. The current increase of maritime trade is expected to continue at a steady pace of 3-4% p.a. through 2020[11].
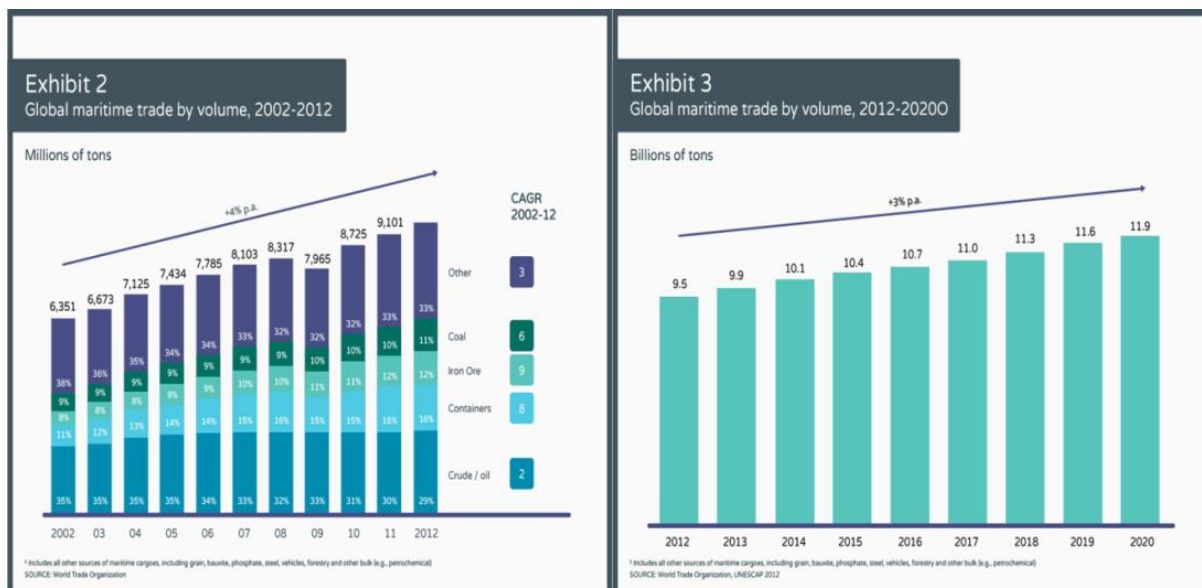
Global Maritime Trade: Development 2002 - 2012 and Prognosis 2012 - 2020

Source: *World Trade Organization, UNESCAP 2012, "Global maritime trade by volume 2002-2012 & 2012-2020"*

The maritime environment of today is experiencing a wide range of challenges which require both a comprehensive approach and collective efforts to address[12]. Maritime Security is a basic prerequisite for smooth functioning of the global economy. Ensuring Maritime Security is a huge challenge facing many entities worldwide from public and private sectors, specifically pointing at

- preserving navigational freedom,
- facilitating commerce, and
- maintaining good governance at sea.

Therefore priority action areas of Maritime Security are:

- International and national peace and security;
- Sovereignty, territorial integrity, and political independence;
- Security of Sea-Lines of Communications;
- Prevention of crimes at sea;
- Resource security, access to resources at sea, and to the seabed;
- Environmental protection; as well as
- Safety of all seafarers and fishermen.[13]

At its core, Maritime Situational Awareness [MSA] – also often referred to as Maritime Domain Awareness [MDA] – is an enabling tool which seeks to deliver the required information superiority in the maritime environment in order to achieve a comprehensive and common understanding of the maritime situation and an overall increase of Maritime Security. With regard to military action, MSA is a fundamental precondition for the effective planning and conduct of operations[14]. As such, MSA is a global challenge and therefore it involves coordination and cooperation with a variety of stakeholders that are collecting, processing, and distributing information to enhance awareness in the maritime sphere. Without effective understanding of maritime domain activities, vital opportunities for an early warning and precise response will be absent. Reacting faster and more efficient than an opponent is a key factor for success, especially for operations in CSW.

2.3. A Common Understanding

Maritime power, both in an authoritative and physical sense, is substantiated by the ability of an actor to gain control over both sea areas of interest (surface, subsurface, airspace) associated to the freedom of movement as well as action within these areas, while concurrently exerting diplomatic, economic and military influence at time and place of choosing. Maritime power has traditionally been employed globally to maintain the freedom of navigation as an essential foundation for the economic prosperity and overall welfare of states; conversely it has been regularly used to disrupt the SLOCs of an opponent. In this regard, maritime forces offer their utility across the entire spectrum of war fighting. First, at an early stage to deter an opponent and/or to prepare the operational environment, then to secure access and establish sea control, followed by power projection – often in a joint campaign or by forces ashore (through strike, amphibious, and/or joint fires operations). Lastly, they are used to secure the withdrawal of own forces.

In order to fulfil such tasks and missions a naval force should be able to successfully operate within the littorals and consequently also within the CSW, as part of the littorals. This convergence zone between the high seas and the coast varies in its extension on both sides of the shoreline. Its limits depend on geographical and operational factors. Apart from mere geographical and military, further aspects – namely political and economic interests – are also to be taken into regard when defining this specific littoral zone.

In military operations, the littoral zone is a coastal region consisting of the seaward area, from the open ocean to the shore that must be controlled to support operations ashore, as well as the landward area ashore that can be supported and defended directly from the sea[15]. The littorals are to be conceived furthermore as a zone extending from inshore into the sea where an adversary may execute Anti-Access or (local) Sea Denial[16].

The area of CSW – being part of the littorals – does not necessarily extend as far offshore or as far inshore as the littoral zone. However, fjord-like environments, deltas, and streams – even vast inland waters – can be regarded as CSW, although they might extend deep beyond the beaches adjacent to the shoreline.

The littorals, especially CSW, offer more natural and geographic challenges to both attackers and defenders than open and deep waters. In coastal waters, for instance, there are greater opportunities for surprise and disguise. The effects of oceanography and meteorology are more distinctive in CSW and significantly complicate operations compared to open ocean. Water depth clearly limits not just the movements of vessels with deeper draughts but also influences the consistency of the element 'water' itself, just like its temperature, the salinity, the condition of the seabed or the character and the shape of the coast itself. All of these factors affect, for instance, the performance of underwater sensors. Similarly, air temperature, wave height, wind speed, humidity, precipitation, cloud amount, or the presence of fog affect, amongst other things, radar, infrared sensors, and radio communications, while haze and other forms of visual distortion affect the performance of optical devices. Furthermore, radio and radar signals can also be distorted by nearby land masses[17]. All of these factors significantly influence military assets both in their employment and performance. In summary, no other maritime area is more directly affected by environmental features than CSW.

CSW are to be regarded as a very particular theatre of operations where the courses of action for maritime forces are limited due to following factors:
- Shallow waters (with a depth less than 200m) increase the threat potential, (e.g. mines and divers), affect sensor and weapon performance (e.g. sonars with reflections, reverberations, and ambient noise) and also decrease the navigational freedom for units operating at sea;
- Narrow straits restrict freedom of manoeuvring, decrease sensor and weapon performance;
- Archipelago-like environments limit the freedom to manoeuvre, decrease the effectiveness of passive and active sensors (e.g. detection range, identification, and tracking performance due to radar clutter), impede picture compilation, and provide optimal conditions for asymmetric threats;

- Jagged and rugged coastlines affect sensor performance, hinder MSA;
- Tidal areas as well as extensive flats and shoals restrict freedom of manoeuvring;
- Rivers and estuaries require particular capabilities and tactics.

Furthermore, CSW also include the landward coastal areas where, for instance, sensors, weapon systems, logistics can be deployed that may influence or impede action at sea. Therefore, CSW is to be regarded as a very specific operational environment[18] with a broad variety of multiple actors, activities, risks, threats, factors and particularities which considerably affect the conduct of military operations.

The following examples illustrate the variety of complex factors to be taken into account when operating in a CSW environment. Of note is that while open ocean operations contend with some of the below listed factors, CSW operations must contend with all and sometimes even more issues:

- Coastal (land) threats (e.g. Transporter Erector Launcher and Radar [TELAR] sites, coastal batteries, Rocket-Propelled Grenades [RPGs], mortars);
- Naval threats of concealed assets exploiting the clutter of numerous islands, islets and jagged or rugged coastlines (e.g. Fast Attack Crafts [FAC], Fast Inshore Attack Crafts [FIAC]);
- Threats posed by submarines;
- Air threats from land and sea based aircraft;
- Mine threats;
- Employment of Unmanned Vehicle Systems [UVS] (under water, surfaced or in air);
- Activities involving divers;
- Asymmetric threats (e.g. Improvised Explosive Devices [IEDs]);
- Flexibility and agility of Surface to Surface Missiles [SSM] capable to exploit CSW environment (e.g. ability to avoid obstacles, bypass geographical barriers to horizontal/ vertical plane, exclusion of land from seeker's search, use of waypoints);
- Saturation attacks by suicide assets such as Rigid-Hulled Inflatable Boats [RHIBs] from multiple directions;
- Easy detection (visual, electro-optical) from ashore, involvement of non-combatants (every person with a mobile phone and a camera is a potential "sensor");
- Local unfamiliar environmental and meteorological phenomena;
- 360-degree threat direction;
- Restricted war fighting manoeuvrability;
- Dense traffic situation (fishing vessels, recreational yachts, commercial trading ships, ferries, commercial and private air traffic, etc.);
- Artificial islands and superstructures (e.g. offshore platforms, fish farms, etc.);
- Environmental data recordings (e.g. hydrophones to secure marine life, etc.);
- Proximity of the public incl. media leading to increased common interest and also elevated risk of collateral damages.

On the bottom line, CSW challenge military operations with a multifaceted and confusing environment. The increased risks must be thoroughly assessed and countered as quickly and effectively as possible since manoeuvring space is restricted and reaction time is significantly reduced. In CSW, naval forces are extremely vulnerable to a variety of both conventional and non-conventional threats that emerge simultaneously or in close succession. Specifically, hybrid threats[19] which attempt to exploit naval vulnerabilities through a variety of asymmetric approaches (e.g. IEDs, suicide assets) pose a lethal danger. In addition, cyber-attacks are undoubtedly extremely critical in CSW as they may jam or deceive technical navigation and weapon guidance as well as surveillance and communication systems (e.g. GPS, Recognised Maritime Picture [RMP], data and voice communication). It is more than obvious that a navy's ability to operate in CSW under unpredictable competitive pressure, whilst at the same time maintaining accurate and timely threat assessment, proves to be increasingly challenging.

Additionally, layered Anti-Access/ Area Denial [A2/AD][20] capabilities are to be faced. They are mainly oriented to increase the degree of friction, to expand a naval zone of influence, and to enhance risks to naval forces operating in CSW. The intensity of the respective sustained multi-dimensional threats raises fundamental questions about the survivability as well as the necessity of naval forces to operate in this most heavily congested environments. Basically having access to the technologies and comparable means utilised by NATO forces, the Alliance has to assume that any opponent may conduct extensive A2/AD missions and along with that could pose a credible threat in CSW. Information technology, precision-guided munitions, stealth technology, unmanned or autonomous vehicle systems, cruise missiles, use of satellite bandwidth are only some of the already available technologies and means. Furthermore, the supplier's willingness to share technologies, the trend to reduced costs by using commercial products and increasingly eased access to international arms markets contribute to this ongoing proliferation.

The inevitable presence of people further adds to this complexity. The masses that actually make their living or commute on inshore waterways exceed their numbers on the open oceans by multiples. Even more, the effect is gaining significance as most of the world's mega-cities are located on or close to the coast[21]. Hence, the CSW environment reflects also urban warfare issues. The assumption, that most of the civilians are going to leave or avoid the area when this operational space is transformed into battlespace[22], may prove to be incorrect. People in many parts of the world are dependent on the unhampered use of the coastal waters and will therefore take what seem insane risks. Unless an area becomes a theater for major conflict, commercial trade and fishing is very likely to continue because any impediments would cause dire consequences[23] to those individuals whose livelihood depends on those means.

In crisis and conflict the presence of neutrals or uninvolved individuals is not just a challenge with regard to avoiding collateral damage. They may also deliberately be exploited to disguise intentions of an opponent, to impede MSA, and may even be used as human shields. The expectation must therefore be that the volume of maritime traffic is likely to remain at normal or near-normal level despite the dangers. Identifying targets of interest within the mass of normal traffic will, in many cases, be achieved only by approaching, interrogating, and occasionally the boarding of suspicious crafts[24].

In addition to the geographic constraints, the high concentration of vessels affects the freedom of action in CSW. Particularly in constricted areas and confusing environments such as archipelagoes, forward positioning of naval forces is extremely risky. Therefore, operational planners and commanders have to take the critical factors of CSW 'mosaic' into account such as:

- Battle intensity;
- Mass and swarm;
- Easy and early detection of larger vessels as a result of high concentration in limited space;
- Constant threat of ambush in a favourable defence terrain;
- Surprise;
- Deception;
- Saturation;
- Identification insufficiency;
- Limited sensor performance due to the nature of CSW;
- Difficulty in maintaining RMP due to dense traffic;
- Abundance of coastal signals (e.g. mobile phones, radio, TV, etc.);
- Vulnerability to the effects of coastal jammers;
- Short reaction times;
- Mutual interference;
- Collateral damage;
- Weapons lethality;
- High expenditure of ammunition and other expendables;
- Information overload;
- Potential extensive or even ineffective logistical support;
- High operational tempo;
- Crew fatigue.

If these aspects are not thoroughly considered it could inevitably result in the loss or neutralisation of highly capable and valuable assets and eventually even defeat. Hence, alternative operational approaches, such as to remain outside this high-threat environment and enter CSW only for the conduct of specific actions (e.g. an amphibious assault), should always be considered. The option of operating as long as possible outside the A2/AD weapons range and at the same time employing stand-off weapons may be interpreted as a 'choose when and where to strike' battle strategy. Certainly this is a way to foster managing CSW related threats and risks. However, this is not an all-encompassing solution as a total avoidance of CSW is highly unrealistic.

The CSW operational environment encompasses the maritime, air, land, space, and cyber domains as well as the information space; in that regard, also all associated opposing, friendly, and neutral systems (political, military, economic, social, informational,

infrastructure, legal, and others). Understanding this complex environment has always required a perception broader than just an adversary's military force and combat capabilities. The specific requirements for, and the particular types of operations in, CSW demand a comprehensive understanding of such systems and capabilities that are relevant for the successful conduct of missions and tasks in this environment.

Notwithstanding different conceptual approaches, which are correspondingly valid depending on the respective point of view, a common understanding on the substantive significance of CSW is of great importance. For example, the term 'confined waters' covers all given attributes, whereby 'narrow waters' just the limitations by geographical constraints resulting in navigational restrictions. Moreover, 'shallow waters' include, in general terms, depth of up to about 200m. However, this does not mean to ignore deeper areas in this environment; it rather has to be perceived in a holistic way. Accordingly, either both or just one of both notions are to be considered. Hence, the term "Confined **and/ or** Shallow waters" appears to best represent the conceptual demands of this environment.

CSW should be also regarded as an adjacent maritime area to the high seas and essential part of the operations area (e.g. for amphibious or reinforcement operations). In this vein, by attaining (local) Sea Control in CSW, smooth and possibly unhindered movement of naval forces approaching from the high seas could be also attained. CSW should also be considered from the aspect of its landward areas, which influence greatly action at sea (e.g. weapon and sensor employments from land, logistics etc.). Bearing all this in mind, CSW are areas of exceptional relevance for military operations. Needless to say, CSW pose a significant challenge to military planners and commanders, easily summarised in the phrase "think broad in a confined space".

CSW should be also viewed from the perspectives both of an 'intruder' (the party approaching respectively entering CSW in order to enable maritime security and/or power projection) as well as of the 'defender' (the party exerting A2/AD). As such, CSW should be anticipated not only as an 'arena of risks and limitations' but also as a 'bouquet of opportunities' that may be exploited to one's own advantage.

On the bottom line, CSW should be perceived as follows:

CSW is a cramped, congested and contested operational environment that is especially characterised by extraordinary complexity, interaction, surprise, speed, disguise plus diversity of actors. Furthermore, the rapid as well as unpredictable change of conditions and circumstances including the frequent shift of tactical advantage from one side to another is typical.

With these attributes, CSW constitutes an extremely challenging littoral battlespace which affects the freedom of movement and action by specific geographical and geophysical factors as well as manifold threats and risks. On the other side, CSW also offers a broad range of possibilities and opportunities for military operations.

Principally being a maritime sphere, CSW is a theatre of operations also being significantly interrelated with the other military domains (air, land, space and cyber). Consequently, the greatest possible joint interaction takes place in CSW involving all major military components and services.

3. Trends and Implications

There are numerous papers on future trends around; most of them are very general and too abstract for a study on military evolvements in a particular field. However, Allied Command Transformation [ACT] implemented the Strategic Foresight Analysis [SFA] in 2013 which provides the required focus and principle level of specification. The SFA identified a total of 15 trends shaping the future strategic context. These trends have been clustered in five major groupings (themes) that serve as the basic structure for this chapter. Furthermore, the SFA details 34 defence or security implications relevant to the Alliance out to 2030 and beyond[25].

In this study, the SFA is complemented with trends expressed in the EU Institute for Security Studies report[26], the Global Marine Trends 2030 report[27], and the Global Trends 2030 – Alternative Words report[28]. In order to crystallise a clear and comprehensible vision, as well as to ensure issuing a streamlined text covering merely aspects with relevance to this work, only those defined trends that touch maritime issues and potentially create future impact on operations in CSW are further elaborated on. Accordingly, based on a brief anticipation on those relevant developments, the respective consequences are to be assessed and deduced.

3.1. Human Theme

Anticipation: Cities will accommodate 65% of the world's population by 2040. 95% of urban population growth will occur within the 'developing nations' and agglomerate in 'mega-cities'[29]. The majority of these concentrated urban clusters will be situated in the vicinity of or right on the coast, thus in proximity to CSW, allowing easy access to trade and other demands. Together with major ports, these mega-cities will become important political and administrative centres, establishing themselves as hubs for international, national, and regional economies. Increased urbanisation is accompanied by the growth of poverty, inevitably fostering the expansion of slums which are expected to contain approximately 58% of the total urban population as early as 2020.

Deduction: Shortages in vital resources, failed infrastructure, increased likelihood of infectious diseases, and income disparities could result in dissatisfaction and rising criminality up to civil unrest in urban areas. Consequently, naval forces may be required to perform peace-support, humanitarian assistance, and stability operations in the urban environment up to and including CSW. Additionally, the Alliance will inevitably expose its forces to greater hybrid, especially asymmetric, threats. This implies that naval forces, which bear the ability to react and deploy quickly and are capable to act as force enablers, should have capabilities for those operations as described above.

Anticipation: Human networks are expanding at an exponential rate with varying effects. Among the societal shifts influenced by human networks, three developments are to be highlighted here: A greater transparency of organisations, the decentralisation of power from traditional institutions, and the democratisation of established social structures. Along with new technologies, they will allow individual citizens to discontinue being mere passive users of information and instead enable them to interact with the information and assume

increasingly active roles in the communication of the news, ideas, and opinions. Human networking facilitated by evolving technology is expanding exponentially at the global level.

Deduction: While human networks bear the potential to create enormous benefits, their advancement generally evolves ungoverned and chaotic. Therefore, also negative tendencies are likely to occur; especially as human networking has already become a medium for transnational crime and unbounded intelligence gathering and sharing. This precarious trend – being a form of (asymmetric) cyber threat – is likely to become increasingly complex, influential, and dangerous in the future. Naval forces conducting operations in CSW and close to mega-city areas should have advanced knowledge to understand and also have the skills to influence human networks. Most important, however, is the ability to assess, and at best mitigate, their impact on operations in CSW.

3.2. Political Theme

Anticipation: The world is becoming increasingly interconnected and polycentric. Future developments and progress (emerging technologies, improved communications and access to modern transportation) will create new empowered – state as well as non-governmental – actors that may compete with already established actors. The exponential increase of information technology and social media enables dispersed individuals to act as an effective organised group within a network. This could encourage, as well as empower, various institutions and organisations to attempt shaping the outcomes of political, social, economic, and environmental issues. Concurrently, regional and multilateral partnerships as well as international institutions and organisations, even private enterprises such as advocacy groups and security providers are increasingly gaining an important role in defence and foreign policy. In this environment, the rising influence of non-state actors, large multinational corporations, and super-empowered individuals, could lead to a perceived decline of the importance of nation-state and governance authorities.

Deduction: These challenges to the state-centric model will increase the overall complexity of naval actions. The progression of a private maritime security sector could have diverse and possibly undesired effects adding to this complexity as the state monopoly on the use of force is challenged or at least partly substituted. Regarding the mentioned trend of human networking, including that of urbanisation entailing more and more mega-cities, operations in CSW environment may evolve into extremely complex processes. Naval forces conducting operations in this environment should have comprehensive situational awareness and advanced substantial knowledge to understand the role and authorities of possible actors, the structure of human networks, and the ability to assess potential threats in a hostile environment.

Anticipation: Limited natural resources, such as water and arable land, particularly in Sub-Saharan Africa, South Asia, and parts of the Middle East, increase the risks of intrastate conflict. Most of the intrastate conflicts will be characterised by irregular warfare, terrorism, subversion, sabotage, insurgency and criminal activities. However, the spread of precision weaponry, such as standoff missiles, will make some conflicts more like traditional warfare. At the same time, a more fragmented international system, an increased resource competition, the spreading of lethal technologies, and spillovers from regional conflicts, may increase the potential for interstate conflicts.

Deduction: The Alliance should be prepared to deploy forces in order to conduct peace support operations at regions suffering from intrastate conflicts. Many of these regions are coastal or at least in the vicinity of the coastline, a factor that imposes the use of naval forces capable to operate in CSW. Furthermore, especially during an interstate conflict in Asia or the Middle East, the following parameters should be considered as possible game changers, that might increase the complexity of naval operations:

- Information superiority will be increasingly vital;
- The capacity of non-state actors might be increased by the proliferation of standoff missiles;
- The distinction between regular and irregular forms of warfare may fade;
- Possible absence of state governance;
- The role of non-state actors;
- An impact of the nuclear element;
- Public ambivalence about NATO involvement.

3.3. Technology Theme

Anticipation: Past wars and conflicts have shown that changes in technology had significant impact on how battles were fought. The accelerating cycles of technologic innovation, along with the fusion of existing and future technologies, will fuel technologic changes and the need for rapid adaptation in the future[30]. Moore's Law epitomises this condition of technological advance that drives related techno-social change[31]. Following this thesis the rapid change in technology over the upcoming decades will almost certainly have a significant impact on the character of war and on the conduct of military operations in the future. Strategy and tactics are considerably influenced by the availability and consequent employment of new technologies[32]. These technologies are to be regarded as one of the major drivers of future kinetic and non-kinetic operations. Miniaturisation up to nanotechnology, automation through to robotics, artificial intelligence, bionics as well as advanced communications and IT-technologies, such as collaboration tools, are simple but illustrative examples showing both the obviously huge potential that technological progress is bringing (e.g. adaptive coatings improving stealth characteristics) as well as on the other hand its challenging effects (e.g. impediments to detection and tracking).

The creative combination of new technologies opens up even more application possibilities especially for military demands. For instance, the spectrum, as well as quality of disruptive technologies including countermeasures or cyber, will further increase[33]. 'Counter-Intervention' capabilities could become available to smaller powers, not just through proliferation by large powers but also simply in consequence of the technological progression. Remote-controlled or self-guided systems, including weapons and platforms, are already starting to shape the operational environment, certainly when being utilised by state-based or state-backed actors. At the same time, there is also a huge potential for the development of advanced underwater and aerial systems – both for surveillance and attack. Directed-energy weaponry may already appear on the battlefield by 2025. In terms of threats that advancing technology poses to navies, not only the weapons are to be

considered but also remote combat enhancers and support that is less visible but can vastly increase the effectiveness of weapons. This category includes, for example, very long ranging and enduring (notably over-the-horizon) or space-based surveillance and targeting systems, electronic and cyber warfare capabilities, and, for the more sophisticated opponents, anti-satellite weapons[34].

Deduction: The consequent utilisation of new technologies is hardly anywhere else of such a vital importance than for operations in CSW. It opens ways to counter the threats or to mitigate the risks in that specific environment and at the same time to best exploit its opportunities. As this operational theatre cannot be left aside or avoided, special focus is to be laid on potentially advantageous technologies. Coming back to the easily conceivable example of 'counter-intervention' capabilities hampering the Alliance's ability to mount operations in CSW, the related risks may be lowered by the consequent waiving of manned systems as well as ensuring effective MSA and sophisticated layered force projection. By 2025 remote-controlled weapons systems may come to dominate the armed forces and navies of the major powers. Similarly, other countries may also have effective remote-controlled systems at their disposal by 2025, which would primarily be used in the CSW-environment. The likelihood of such events taking place is increased by the proliferation of technology; the use of unmanned vehicle systems by insurgents in asymmetric warfare scenarios is becoming more and more likely. All this implies that forces operating in hostile and complex CSW battlespace would have to include capabilities to conduct operations in the full spectrum in order to achieve the required dominance. This is primarily determined by the factors of time and space. A limited space decreases reaction time and requires advanced situational awareness and support for decision making. Therefore, staying on the forefront of technological advancement is a prerequisite for future operations in CSW.

Anticipation: A globally connected and intertwined world through manifold kinds of networks creates a sphere of universal access to information. Highly interconnected networks are vulnerable to infiltration and cyber-attacks from multiple sources. Already the potential for cyber-attacks, espionage, and attacks against Alliance networks or military systems has increased but the number of cyber-attacks is anticipated to significantly rise in the years ahead.

Deduction: The importance and influence of electronic tools and resources for strategic communications will continue to grow. For certain, naval forces operating in CSW will increasingly face cyber threats. For instance, networked maritime unmanned systems will be operated by using the cyber space; and the dominance of cyber space is paramount in all environments. In general, naval forces which are deployed in CSW should also be able to conduct operations in cyber space or at least secure their own operations against any cyber-threat.

3.4. Economics and Resources Theme

Anticipation: The international economy will most likely continue to be characterised by various regional and national economies developing at significantly different rates. Such contrasting speeds exacerbate global imbalances affecting governments and the entire international system. Furthermore the world's present economic system will be influenced

by a new league of economies that will affect the equilibrium. The rising economies will consolidate their position and even expand their strength, being regarded as a safer place for investment and growth. Additionally, global trade liberalisation and interpenetration will accelerate economic growth.

Deduction: Global trade will further increase; especially the intra-regional trade which will nearly double by 2030. Global maritime trade will boom especially in the following regions: Intra-Far East; between Far East and Oceania, Latin America, and the Middle East. Accordingly, we will also see the strongest growth within these trade routes. This will further increase the significance of the major international shipping routes running inevitably through CSW as they are vital connecting links between the (major) ports as well as the (mega-) cities. Hence, the ability to secure these SLOCs in the CSW environment is essential. Therefore, the Alliance must provide superior capabilities to exercise (local) sea control in a disputed littoral area. Naval forces conducting operations in a crowded and target dense CSW area should have advanced abilities in maritime surveillance with sophisticated sensors as well as effective weapons and enhanced C2 equipment including options for ad-hoc Civil-Military Cooperation [CIMIC]. They must be able to meet the requirements for the entire spectrum ranging from the conduct of disaster relief operations up to high intensity warfare missions.

Anticipation: Both growing human population as well as global economy will inevitably lead to mounting resource and food consumption. Although rapid technological advances and increasing efficiency may curb the projected rise, it can be assumed that the ever growing demand for raw materials and nourishments will further increase. Along these lines, offshore exploitation of raw materials will gain importance, but at the same time marine mining will become more and more accessible and thus more economical. Nevertheless, the rising nutritional demand remains a vital issue to mankind as starvation and malnutrition are capital drivers for social unrest, riots, and revolts, easily creating areas with reduced governance up to failed states. Additionally, global warming will affect the rural sector. In the equatorial zone desertification will progress whilst the agricultural cultivatable zone moves further towards the poles. This will not compensate the rising demand on arable farm land but rather trigger a parallel shift in prosperity contributing to wealth inequalities and increased political and social tensions. Although food supplements might lessen these challenges, the share of seafood in world nutrition and along with that the amount of ocean farming will accelerate.

Deduction: The relevance of the maritime environment, especially of the EEZs and sea beds, for world resource supplies will further increase. This will inevitably lead to an increasing quantity and magnitude of disputes which, in turn, will lead to intensified involvement of navies particularly in EEZs, the littorals, and especially CSW. Naval forces conducting operations to safeguard the unhampered use of the sea for the exploitation of raw materials and marine food supply must have the capabilities at their disposal to dominate the maritime domain, especially the CSW-environment. Additionally, they must have long endurance and self-sustainability.

3.5. Environment Theme

Anticipation: Coastal areas with mega-cities are very vulnerable to the climate change and hence will be strongly affected. These areas will suffer from more frequent storm periods causing erosion and other ecological effects. Melting ice at the poles will undoubtedly lead to a rise of the sea level and heavy rain will also cause extreme flooding and significant environmental and infrastructure damage as well as human suffering and disasters. This will also have a direct impact on the availability and quality of fresh water and food.

Deduction: Along with the increasing relevance of coastal areas for mankind and aggravated need to deliver humanitarian aid to that region, navies – being forces that bear the ability to react and deploy quickly in the global theatre to regions with high population density – will gain importance. Although rapid initial aid can only be ensured by airlifts, naval forces should also be able to conduct or at least support humanitarian aid and sustained disaster relief operations in CSW.

Anticipation: Global warming and climate change are causing the ice to melt at the poles, thus improving access to the Arctic as well as Antarctica and will potentially allow for growing exploitation of natural resources in previously inaccessible regions. Furthermore, seasonal ice may no longer restrict the use of Arctic maritime trade routes that significantly reduce transit times notably between Europe and Asia.

Emerging Arctic Sea Routes

Source: "Arctic sea routes - Northern sea route and Northwest passage." UNEP/GRID-Arendal Maps and Graphics Library. 2007

Deduction: From a geographical point of view, a new focus area will arise in the Arctic waters that may be regarded as 'confined' and in parts of the passages also as 'shallow'. Intensified human activities in the Arctic and Antarctica will raise many issues requiring basic arrangements such as search and rescue responsibilities. However resource exploration and exploitation may not easily be governed especially in these regions and rather trigger a danger of enforcing economic or political interests.

Naval forces operating in the emerging arctic focus area must be able to conduct operations in a very harsh environment with extreme conditions. Security cooperation and other military-to-military forms of collaboration establish, shape, maintain, and deepen international relations as well as the partnerships necessary to meet security challenges and reduce the potential for friction[35] in the arctic zone. This evolving CSW region will constitute a particularly abnormal operational domain of growing importance which should be analysed and assessed with a great amount of diligence.

4. Future Demands and Challenges for Operations in Confined and Shallow Waters

After elaborating on the particulars of CSW including their consequences for military, especially naval operations and after providing a concise description of future developments with regard to this environment it is now time to bring both together in order to project a future vision. A structured systematic approach may be gained from focusing on categories that are relevant for prospective operations in CSW such as 'battlespace', 'warfare', 'actors' or other 'parameters' and by questioning in detail, how each of them will be influenced by future trends. Furthermore, some first ideas and general recommendations are provided, in which ways navies could manage arising challenges.

4.1. A Battlespace of Rising Complexity

As part of the transition zone interfacing land and sea, CSW are at the very heart of that sphere where all military domains interrelate – the military theatre with the largest share in 'jointness'. In other words: CSW are an essential battlefield of increasing importance, while also facing the challenges that arise from growing complexity.

Without question, the geographical environment of CSW is very challenging, which creates manifold natural and manmade obstacles for military, in particular maritime operations. Already, and expected to be even more so in future, CSW are heavily trafficked areas. Besides the commercial traffic on main global maritime routes intersecting the littorals as well as the regional and local coastal transportation, a broad spectrum of further marine traffic is noticeable – of course regionally varying. This increasingly dense traffic provides favorable conditions for illegal trafficking. In addition to the confusing terrain and the multitude of contacts, artificial islands and superstructures as well as critical maritime infrastructure such as gas and oil rigs, wind energy generators, and other exploration platforms will increasingly exert a tremendous influence on operations in CSW and consequently further enhance the already challenging complexity of this battlespace.

The rapid technological progress has facilitated the acceleration of information technology taking a key role in today's operational area. This has in turn made cyberspace an increasingly crucial aspect within the battlespace. Consequently, new notions like cyber warfare come more and more to the foreground and are expected to raise even more concerns in the future. Areas of specific impact will include congested and cramped environments where many possible threats appear simultaneously.

In other words, this additional factor will further increase the level of complexity and ambiguity in the operational space by the variety and high number of threats hidden amongst the even larger amount of contacts and available information, affecting especially MSA. If the vast amount of information is not thoroughly evaluated, processed, maintained, and efficiently distributed in such a restricted space as CSW, all the actors within it could easily fall victim to information overflow resulting in a kind of hazardous 'blindness'. From an attacker's point of view, these multi-dimensional/asymmetric threats in concert with 'surprise' generate a formidable combination of possibilities. The impact of such possibilities is increased exponentially by the peculiarities of this environment.

In connection with 'surprise', CSW are also characterised by 'speed'; speed of data exchange and picture compilation, speed of command and control, speed of (re-)action. In order to be faster than an adversary and also to maintain the initiative, 'speed' must remain a key-requirement in any future military campaign, particularly those involving CSW. This will be achieved through knowledge decision and technological superiority (e.g. Artificial Intelligence [AI]). In the near future, AI will likely continue to be context-specific, restricted to certain types of problems. Expansion to a broader context or stepping outside the frame of a particular problem will still require a human interface. However, as machine intelligence advances the functional comprehension and decision competence of AI will progress, being increasingly able to operate in complex environments[36]. Their importance and gravity in shaping the outcome of a campaign will steadily increase over the coming years.

The battlespace in CSW is heavily influenced by densely urbanised areas. Those are melting pots where social, economic, and political interests easily come into conflict, being superimposed by the overarching technological progress. Coastal mega-cities will especially complicate and greatly challenge combat missions as well as the political, social, and economic landscape in the future. The tendency for people to cluster in that sphere of gravity in concert with intensified connectivity among them will further increase this complexity. As such, military action ashore will affect significantly the maritime environment and vice versa. And, in having also the interdependencies of the strategic, operational, or tactical level in mind, any reduction of discrete distances among these levels as well as among combatants and non-combatants enhance the demand for

- changing the character of military activity (which implies changes to military mindset governing the current status), as well as for
- sound judgment, especially an enhanced ability to distinguish abnormalities in a blurred environment.

Returning to cyberspace; this is the latest aspect of the modern battlespace undoubtedly transforming communication in the information age. NATO defines four domains as Global Commons: air, maritime, space, and cyberspace[37]. It is important to identify and clarify the interests in each of these domains as well as to understand the implications and complexity of an increasingly inter-connected world, to grasp the nature of threats to those interests, and to allocate resources as efficiently as possible to counter threats and reduce related risks. 'Cyberspace' is related to 'information and data flow' whilst 'maritime' is primarily related to 'security' also for instance involving commerce, trade and critical infrastructure both being vital for an unhampered flow of cargo and values. But how do data flow and the flow of cargo or values interrelate?

Still there is rather limited awareness of factors from the cyberspace and their influence and potential threat to the maritime domain and in particular maritime security in the various interfacing levels. Actors from around the world, whether they are individuals or threat networks, may easily impede operations in CSW by misusing the cyber space. This should be considered in direct conjunction with the dissemination of modern technologies, openly available at very small cost and ready for use. Partial non-availability of information technology as a result of cyber-attacks will affect companies that are either directly or indirectly related to sea-trade, sea-tourism, or any other kind of maritime commerce. This

may cause significantly negative affects to social, organisational, and governmental structures as well as the financial markets. The list of imaginable hazards must be extended to include not only individual losses, like ships or life, but also the massive after effects following in the wake of events such as deliberately provoked environmental catastrophes or major disasters (e.g. a maximum credible accident in a nuclear power plant) which very often are located at or very close to the shoreline.

Thus, enhancing cyber resilience[38] is tantamount to increasing security in the maritime domain, which is in turn nothing else but an improvement of cyberspace security. An interactive maritime cyber response process is an appropriate way to prevent, detect, assess, and respond to cyber challenges in the maritime domain. Such a coordinated process expands cyber domain awareness and provides a constant military assessment of both compliant and non-compliant actors – necessary to be conducted on all command levels.

On the bottom line, the maritime, and in particular the CSW-environment, should be recognised as a highly complex battlespace where a network of innumerable stakeholders and individuals is active in manifold specific realms and levels, sharing obvious as well as hidden dependencies of various intensity. This requires a concerted, effective interface analysis approach for efficient cyberspace security as well as an established 'cyber situational awareness'.

4.2. Advanced Warfare

Besides the growing hybrid and cyber threats, the conventional threats from regular military forces and means must not be ignored. The Alliance must prevent any decline of expertise and capabilities in warfare areas with regard to operations primarily in CSW maritime warfare areas and especially those with CSW-specifics such as Anti-Surface Warfare [ASuW], Anti-Submarine Warfare [ASW] or Mine Warfare [MW]. Indeed the unique characteristics of CSW entail particular actions and methods in the whole spectrum of warfare areas. Recalling the special water conditions (e.g. changes in temperature or depth, geophysical and hydrographical features etc.), Under-Water Warfare [UWW] is one of the main areas which is affected significantly by these particulars, as well as Above-Water Warfare [AWW] taking especially the geographic restrictions, weather conditions, high density of commercial and non-commercial traffic, freedom of manoeuvre, etc. into account. The increased air threat due to the proximity of shore based assets requires sophisticated layered Anti-Air Warfare [AAW].

As a fundamental rule, along with technological progress, inevitably come new forms of belligerence. Adequate ways to tackle such challenges need to be developed and applied to mitigate challenges to operations in CSW as well as to seize respective opportunities.

Therefore, at least the following innovative technologies are to be assessed with regard to their potential to support operational demands in CSW:

- Artificial intelligence;
- Smart networks;
- Advanced computing and big data;
- Automation;

- Miniaturisation;
- Nanotechnology and spectrally-sensitive technologies[39];
- (Micro) Robotics;
- Bionics;
- Additive manufacturing (e.g. 3D- printing);
- Advanced ship-building technologies (e.g. stealth) including construction (e.g. SWATH or high-efficiency engines) and material (e.g. laser-welded metallic sandwich panel technology).

These technologies foster leading the technical edge, in particular facilitating advancements of capabilities/features required especially for operations in CSW such as:

- Fully-automated (unmanned) platforms;
- Long-endurance (loitering systems);
- Additive, electric weapons;
- Directed energy weapons (lasers);
- Precision attack ammunitions;
- Advanced sensors (bi-static and multi-static sonar and radar systems, software radars, high resolution imaging systems etc.);
- Advanced jamming and deception systems;
- Utilisation of space-based surveillance;
- Enhanced (self-)sustainment[40];
- Reduced detectability;
- Improved stability/ collapse resistance;
- Less affection by environmental exposures.

These innovative developments trigger a dramatic progress – leading to significant effects with the result of a 'force-multiplier' or a 'game-changer' – that can improve, facilitate, or even impede operations in CSW. Hence, being ahead of the technological advancements is a critical imperative!

A large part of underwater challenges in CSW stems from naval mines, not just with regard to their potential geographical extent and immense variety, but also due to their probable impact as they bear the danger of a unit-kill and as they may further restrict the navigational freedom (i.e. Sea Denial). Naval mines should be expected to remain at the forefront of maritime threats because they are mostly unsophisticated and relatively inexpensive. Therefore the cost effectiveness remains high as well as their prevalence. Mines are easily deployable in CSW by anyone (state or non-state actors) with the proper means (military assets – such as warships, submarines or aircraft – and all kinds and sizes of non-military vessels). They run the gamut from do-it-yourself constructed underwater explosives (IED) to military grade ground, moored, and drifting mines. Their employment methods are as various as their types and can be offensive, protective, or defensive; overt or covert planted; random or systematically planned and executed mined fields. Modern naval mines

can be laid inert and be remotely activated and deactivated again or they can remain dormant until a designated target is in detection range and then activate a target-seeking warhead like a torpedo. Furthermore, tactical devices like ship-counters harden minefields against Naval Mine Counter-Measures [NMCM]. Naval mines may be used in many waters, but their main operational area is the CSW-environment, especially in notoriously traffic dense areas such as harbour entrances, straits, or narrow sounds.

The naval mine threat has increased during the past decades especially with regard to lethality and sophistication. Despite the technological advances, active NMCM and the passive reduction of mine threats will remain a tough task in the future, especially in such adverse environmental conditions as seen in CSW. In order to optimise new systems for operations in CSW, they must have appropriate self-protection against mines. NMCM systems must be able to detect and identify, as well as neutralise or dispose, state-of-the-art mines in CSW; this includes waters up to the surf zone. They must be silent (modern mines may include sensible anti-MW systems) and their endurance, sustainability, and specifically their survivability against three-dimensional threats (plus cyber-attacks) should be taken into consideration. Technological advancement must be exploited to the best possible use for NMCM. Unmanned Vehicle Systems [UVS] for military operations are developing at an increasing pace as they eliminate the risk of own casualties or losses whilst being extremely efficient. Thus Maritime Unmanned Systems [MUS] using remotely controlled or pre-programmed platforms, with applications such as bottom mapping, will increasingly contribute to NMCM or mine reconnaissance.

Generally, technologies for autonomous, unmanned, or remote controlled systems have advanced to a point of sophistication that will, without any doubt, give them a largely expanded role in future operations. On the downside these systems will be more accessible to none-state actors including terrorist and criminal organisations or even individuals. This is to be assumed as these systems may be produced not just by the defence industry but also increasingly by small manufacturers and backyard workshops.

Another significant innovation may be new ways of employment, for example swarm mass use tactics[41]. Future unmanned vehicles are likely to be increasingly modular, autonomous[42], self-sustainable and intelligently networked through secured and cyber protected links. Furthermore – despite legal concerns – artificial intelligence will enable completely independent service including full-fledged combat decisions and battle assessments. Therefore, the application options of these systems will further increase. It takes little effort to imagine their growing value in electronic warfare, close air support, ISR (air, surface and under water), NMCM, small-boat interdiction, and even strike missions. In effect, such systems may compress significantly the decision cycle and thus speed up the operational tempo, which is a critical factor in CSW.

Situational awareness is paramount in any environment. Detection, identification, tracking, essentially the whole process of picture compilation, and information fusion, including the share with relevant actors, are additional challenges in CSW. Environmental effects to sensors caused by atmospheric influences can be predicted only in a limited way. The aforementioned high density of traffic, namely the huge number of movements in CSW, raises the need for a comprehensive and detailed maritime picture. Increased air traffic, as

well as lethal underwater threats, require nothing less than a recognised picture in these dimensions. Therefore, the development of superior capabilities to filter, analyse, and process the situation – including innovative supporting tools and mechanisms to facilitate decision procedures – will be prerequisites to meet future MSA requirements for the complex CSW environment. In that regard, a network-centric approach is deemed to be appropriate, where every node of Command, Control, Communications, Computers and Intelligence [C4I] should be inter-connectable in a flexible way, enabling quick reactions to any tactical/ operational change or development, thus allowing key systems to exchange their operational status automatically and enable enhanced individual performance.

Moreover, to ensure the survivability in CSW, C4I systems must remain operational in case of any degradation of the situational awareness. This implies that the organisation should be very lean, mission and tasks must be crystal clear, and the understanding of the operational freedom of action must be defined (i.e. applicable and appropriate Rules of Engagement [ROE]). This approach will ensure at all command levels the most flexible and efficient reaction to emerging threats.

When operating in CSW, actions must be characterised by decisiveness and decentralisation in all command echelons. The full comprehension of the mission and a precise, recognised common operating picture are to be ensured; as well as high readiness, manoeuvrability, agility, and flexibility in the chain of command, thus enabling flexible responsiveness.

Despite enhanced support from sophisticated systems, the need for skilled on-scene-commanders who are capable of taking appropriate action in a rational and timely manner remain essential. This can be achieved by further developing mission command, both in skills and systems, in order to meet the requirements of operations in future conflicts. Essentially, with regard to command structure and authority, decentralised command and control remains a key factor in CSW operations.

Operations in CSW will most likely encompass all military domains (maritime, air, land, space, and cyber). Hence, regarding the example of 'policy', main emphasis will increasingly lie in joint and combined efforts, generally focusing on the effective whole and less on unilateral national approaches or single services. In a nutshell: Interoperability and joint operations will increasingly be a prerequisite for success in CSW.

In respect of the paradigm of 'procurement', an 'all-in-one solution' that is suitable for every purpose and meeting every complex requirement is an unattainable goal. For instance, in aiming at a practical all-round setup providing required CSW capabilities on the smallest possible platform, being at the same time world-wide deployable, sustainable, and fully integrated in all operational networks, poses an inextricable conflict of objectives. This dilemma can either be mitigated by abandoning high-level objectives and making compromises or it can be countered by innovative solutions such as an overall systemic approach. The latter combines autonomous devices for basic tasks with smaller – if need be, manned – platforms for specific purposes mounting respective modules that allow flexible adjustments to the operational demands. Large docking ships round up this approach in order to ensure world-wide deployability, superb sustainability, on-site swap of modules, as well as comprehensive execution of command and control. In summary, it seems to be

impossible to meet all required specifications. However, in order to optimise any gains, they should be categorised in various segments. Each of these should be separately focused by applying the proven capability planning categories.

Ultimately, a new mindset is required. Not just for navies, but for the other services as well. NATO members especially need a common approach, leaving national vanities behind for the benefit of the Alliance through increased interoperability, with the overall goal of achieving success in future operations.

4.3. Diversity of Actors

A broad variety of heterogeneous 'players' is active in CSW, most of whom use CSW in a peaceful way, while potentially creating implications to military operations. However, some actors operating in CSW environments may be connected to threat networks or be pursuing other malicious intents calling for governance up to the employment of military power. This spectrum, relevant for operations in CSW, ranges from:

- Ill-equipped – however, very determined – individuals (e.g. criminals or insurgents), over sophisticated and capable paramilitary groups (e.g. terrorists or militia), up to well-organised, -equipped, and -trained military forces (multi capable incl. increased A2/AD, hybrid, cyber);

- State actors (e.g. military forces, cost-guard or police) and Governmental Organisations [GO] (e.g. hydrographic services) to non-state actors such as commercial actors (e.g. shipping companies or fishery) as well as Non-Governmental Organizations [NGO] (e.g. humanitarian aid organisations or Private Maritime Security Company [PMSCs]);

- Democratic states with separation of power and rule of law over totalitarian states up to rogue nations;

- Recognisable soldiers on the battlefield over hybrid warriors without nationality markings up to invisible cyber warriors fighting in front of their PC, free from battle stress - and enjoying the anonymity provided by the cyber domain.

In general, a partial reversal of the military modes of action along with a diversification in basic policies is to be expected. State actors are likely to develop capabilities for the conduct of asymmetric approaches[43] and bring them back to bear[44] (e.g. in avoiding extensive force-on-force engagements by waging long-term insurgencies designed to exhaust the opponent). At the same time non-state actors are likely to embrace conventional forms of war (e.g. in copying specific methods of attack or in taking advantage of the technology diffusion by utilising high-tech armament such as high-end sensors, guided weapons, space and cyberspace systems[45]).

Actors using the cyber domain to pose threats or carry out belligerent acts will become a more important factor to be considered in future operations. Information networks may be utilised for more than just waging a propaganda war; they may be exploited – not just by cyber warriors – as the primary means of communication and information exchange in order to synchronise and coordinate combat action[46]. Actors will no longer have to operate only in a geographically restricted environment such as CSW, but may be externally positioned

anywhere in the world using information technologies, with relatively little immediate risk, to generate effects "inside" an Area of Operations [AOO]. Growing cyber and hybrid threats from non-conventional forces and means will make the conduct of operations in CSW increasingly demanding. It will challenge the military modus operandi even more in the future. As such, advanced capabilities will be required and further evolved. ROE should be considered to deal with threat networks, especially when not acting inside a defined AOO.

The emergence of armed private security actors, such as PMSC onboard merchant ships, is also to be noted. Such actors may provide enhanced protection to threatened vessels and therefore make an important contribution to Maritime Security. However, they operate outside any military chain of command or governmental control and thus may not (necessarily) pay regard to ROE. Further expansion of the private security sector is very likely; for instance future employments of PMSC to secure also offshore critical infrastructure or even execute coast guard tasks are quite probable. Hence, PMSC could evolve to partly relieve regular military forces. In this context, opportunities for cooperation with private security sector are to be further explored in order to address and tackle common threats and necessary arrangements should be fixed (e.g. legal status or widely acknowledged policies and procedures).

The aforementioned variety of actors in such a complex and unique environment like CSW – where operations are challenged not just by very specific geological and physical, but also by difficult command and control conditions such as coping with potentially degraded and blurred information – will render the distinction between combatants and non-parties extremely difficult. The increasing public and private involvement in future conflicts demand enhanced discrimination and threat assessment capabilities. On the other side, there may also be beneficial cross-domain synergies between military forces and other agencies, such as NGOs or PMSCs. Hence, a comprehensive approach through extending military/ maritime networks and connecting them to other organisations, institutions and agencies related to Maritime Security should be a matter of further consideration, potentially resulting in a significant contribution to the overall global effects approach.

4.4. Main Parameters for Prospective Operations in Confined and Shallow Waters

Direct engagements between the major powers cannot be precluded; but they remain to be not very likely to happen especially due to the nuclear stalemate. As long as the overall supremacy of the Alliance is indisputable, the risk of a major conflict may be reduced. In any case we are not living in a world of comprehensive peace. Incompatible political, social, and cultural (including religious convictions) systems, as well as a mutual desire for conquering economic interests, bear an inherent and enduring potential for conflicts involving force of arms. In this context, maritime operations are not foreseen to be carried out in a large scale scenario in the future but rather in the manner of the recent years. Thus, local or at worst regional conventional conflicts are to be expected because of the strive of some states for hegemony and of rising nations, rogue states, or transnational groups of terrorists to expand their sphere of influence by carrying out belligerent acts, including executing limited wars. Although NATO must retain its genuine defence capacity for large scale conflicts, the Alliance has to prepare for smaller scale conflicts that are virtually always linked to operations in CSW.

Future conflicts in CSW will be characterised by short notice, rapid escalation, limited duration, and high intensity leading to increased mortality as well as danger of collateral damages; all this taking place simultaneously or consecutively and being conducted in the way of 'conventional' war-fighting. Operations below the threshold of war, for instance constabulary and humanitarian missions aiming at supporting stability in concert with civilian organisations and entities, should also be expected to be conducted in CSW. These operations will be multi-faceted and generally conducted without the use of weapons. However, elements of high intensity combat may not be completely ruled out, for instance in policing missions. The Alliance is well advised to provide capacities for the entire range of potential tasks. Thus, NATO should be prepared to have appropriate capabilities at its hand which are optimised for operations in CSW.

The age of global economy inevitably implies the emergence of related risks and threats. Prospective targets in CSW are likely to be the maritime trade, critical maritime offshore and coastal infrastructure, facilities and installations such as wind power plants, oil rigs, sea-cables or ports navigation systems and other technological equipment. Undoubtedly, all these constitute high value targets and also potential cyber-attack targets.

Such challenges are of general public interest and significant for the entire human community. Consequently, maritime forces must be well prepared to support the common security. Any stake of the Alliance in this matter spins off into enhanced Maritime Security especially in the challenging CSW-environment. Generally, as world trade will be more than ever dependent on unhampered seaways, SLOCs constitute potential targets, vulnerable to assaults.

In mirroring these basic characteristics of future conflicts towards the previous findings, they will have following dire consequences for CSW:

- An even further rising complexity (enhanced variety and number of actors, threats and risks in a congested and contested environment);

- More inscrutability (heterogeneous mixture of numerous actors that are increasingly interconnected and not necessarily physically present, often hiding amongst uninvolved third parties and hence difficult to be distinguished);

- Quantitative, as well as qualitative, advance of unmanned and autonomous systems (in a strategic role, reducing the crew risks and being very cost-efficient);

- Decline of 'symmetry' in warfare (unequal opponents by definition but equal by technology as well as more and more by tactics);

- Growing importance of the cyber domain (advances in cyber technology increase the need to control the cyber space and concurrently to deny its use by opponents);

- Accelerating speed entailing a higher operational tempo (crisis response on short notice, more frequent and drastic changes to the tactical as well as operational situation with little or no warning on the battlefield);

- Incremental lethality (rapidly staggered attacks of short duration, carried out with high vehemence and sophisticated weapons);

- Increasingly dense and contested operational environment (due to urbanisation, development of trade, exploitation of natural resources etc.);

- Overload of information;
- Fading distinctions between military-civilian and public-private perceptions as well as perceptions of sovereignty (e.g. PMSCs acting in Maritime Security).

As such, prospective operations in CSW will pursue the following general objectives:

- The unlimited access to:
  - The maritime portion of the Global Commons;
  - The AOO;
  - Key coastal strips/ infrastructure ashore (in case of joint operations).
- The freedom of:
  - Action/ operational manoeuvre (gaining/ maintaining the initiative);
  - Navigation.
- The protection of:
  - Maritime trade and SLOCs;
  - High value assets;
  - Critical infrastructure, both sea borne (like platforms, ships) and ashore on the coastline (power plants, harbour facilities) in all domains;
  - Computer networks and technologies sensitive for military operations.
- The ability to:
  - Deploy world-wide;
  - Prevail in a hostile CSW-environment;
  - Establish (local) Sea Control;
  - Perform effective MSA;
  - Carry out enduring operations;
  - Respond in a scaled but decisive way (having capabilities at one's command to counter insurgency and terrorist actions up to conventional force-on-force combat).
- The enforcement of:
  - Governance;
  - The Rule of International Law;
  - Maritime Security.
- Support to actions ashore/ interaction with forces ashore.

To clarify once more: In no way do these aspects imply that conventional areas of maritime warfare are to be neglected. The capability to prevail in operations against sophisticated opponents is always to be regarded as a core capability. The traditional symmetric threat will thus remain as a fundamental and integral part of future capability evaluations. However, the portfolio of required capabilities must be expanded to counter asymmetric as well as hybrid and cyber threats which, in the future, are likely to be the main maritime forces employed in CSW.

Bearing all that in mind, future naval forces need to be well-organised, well-equipped, and well-trained to conduct all types of joint and combined operations. In CSW, it ranges from humanitarian aid and disaster relief over small-scale contingencies up to major war fighting conflicts, be they regular or irregular oriented. In that regard, consequent and

realistic training, war-gaming, synthetic training, and live exercises incorporating CSW-characteristics must be considered.

4.5. Future Operational Consequences

Operations in CSW are affected by all military domains and have an intimate relationship with the information space. This includes associated adversary, friendly, and neutral systems (political, military, economic, social, informational, infrastructure, legal, and others) which are relevant to this specific environment. The diverse conditions and circumstances are to be considered upon the employment of capabilities and thus bear on the decisions of both the commanders and responsible planners. Understanding the full spectrum of consequences that the specific operational environment of CSW generates has always included a perspective that is broader than just taking the military forces, specifically combat capabilities, of an adversary into account. Undoubtedly, a comprehensive view on all aspects relevant to the operations and missions is a major key to success.

The geography plays a fundamental role in CSW. In concert with the operational key-factors, such as space, time, means, and actors, the environmental specifics of an operational area sharpen and shape the mode of conceptions, decisions, and consequently the way we carry out operations and fight. Apart from geography, the key-characteristics will be transformed in the future[47].

The perception of the CSW battlespace must be expanded. It is to be assumed that in the future many parallel missions are to be conducted simultaneously and as such not in a linear way as in the past. Accordingly, operations will encompass the entire battlespace. This upcoming multi-layered and multi-dimensional operating environment demands respective approaches, capable of providing appropriate choices and courses of action, focusing primarily on the required effects and less on available means. This also demands timely prepositioning or at least a very rapid deployment and extensive (self-) sustainability as well as fully networked structures ensuring an adequate access to relevant information for all levels, even for individual soldiers conducting single-person tasks.

Furthermore, the need arises for scalable capabilities that are more adaptable and agile to the full range of military operations across the entire spectrum of missions. In order to preserve the operational tempo and sustain the initiative as well as to be extremely precise and effective, all necessary capabilities must be available right away in the required quality and quantity; if need be providing lethal power with precision and a proper allocation of ammunitions instead of relying on massive firepower. At the same time, Tactics, Techniques and Procedures [TTP] are to be (further) evolved, for instance, to better synchronise surprise and deception. Indeed, there are ways to deprive an adversary of recognising own intentions:

- Concealing movements and actions through enhanced operational security as well as tactics and the employment of camouflage or stealth technologies;
- Imposing successive dilemmas in order to strain the situational awareness of an opponent (e.g. saturation, deception);
- Creating gaps in adverse integrated systems;
- Using a comprehensive way of thinking;

- Concealing courses of action; and finally

- Diminishing the capacity of an adversary's coherent resistance (capable of exerting multi-layered courses of action).

Generally, advanced situational awareness as well as knowledge management aiming at achieving information superiority and thus contributing to an operational dominance in CSW should be further key-enablers. The following features (also being basic prerequisites for operational success) are to be tailored to greatest possible extent:

- Small in size;

- Agile in manoeuvrability;

- Flexible in tasking options (also with regard to varying requirements required in the different operational phases);

- Capable of achieving multiple mission objectives;

- Survivable in a multi-dimensional threat environment;

- Fully networked;

- Sustainable in logistics;

- Able to deliver precise effects in depth.

Cooperation and interaction with all relevant actors, not only military services but also governmental agencies and NGOs, should be a prerequisite to achieve any successful outcomes of prospective operations in CSW.

5.   Conclusion

Confined and Shallow Waters are a challenging environment with a broad spectrum of particularities that contribute to its unique complexity and significance. The latter is deduced from the fact that CSW are the very focal point of the littoral transition zone that not only connects the high seas with landmasses, but furthermore involves all dimensions relevant for mankind. This environment will play even more a vital role in future conflicts and subsequent military operations. Due to the contested and cramped character and the very specific operational conditions CSW increasingly constitute an extremely challenging environment for military commanders planning and conducting joint and combined operations.

CSW are to be seen as a unique and demanding theatre of operations that is subject to many restrictions and limitations as well as manifold threats and risks. This suggests avoiding such an environment and rather carrying out any necessary military action from a safe distance. However, there are numerous missions that require physical presence in CSW. Moreover, it should certainly be considered that a 'risk' for one side may be an 'opportunity' for the other. The CSW-environment can be exploited in the interests of both sides, whether operating from the sea towards a coast or denying such intentions. These aspects are to be thoroughly considered and consolidated in a complementary approach: CSW as an operational environment placing manifold dangers and restrictions that are to be mitigated, while offering advantages that are to be exploited to the maximum extent.

The anticipated trends and drivers are to be regarded as aggravating factors likely to further accentuate the already existing intricacy, thus making future operations in CSW even more demanding. The rapid and unpredictable technological progress intensifies this development, along with an increasing relevance of the cyber domain that facilitates a further expansion of human networks. This in turn enhances the connectivity and, as such, also the ability of anonymous groups and individuals to abuse this sphere for illegal activities up to belligerent action.

Another significant development is the global warming that creates increasing consequences for future operations in CSW. In bringing certain areas, such as the Arctic region, more into focus, beneficial opportunities are created as well as considerable potentials for conflict, which demand very specific capabilities. The rapid increase in exploitation of natural resources is also to be mentioned, next to the further evolving urbanisation – predominantly on or close to the coastlines. All these developments will contribute to augment challenges in CSW which is even more clearly expressed by the further growing economy in an increasingly interdependent world being reliant on unhampered international shipping routes.

The progression of new technologies is without question a key factor influencing future operations not only in CSW. A prominent example is the increasing employment of unmanned and remote controlled systems by regular forces but also by non-governmental actors and down to individuals. In that context the legal aspects regarding these systems need to be clarified. Such systems will play an incremental role in future warfare although the level of automation and its potential applications cannot be fully predicted. However, their value for operations in CSW is assessed as high, as they will at least open ways to ease some basic difficulties and major challenges to some degree. They may open new operating options in a high risk environment. At the same time the development of new tactics and procedures to operate and counter these systems will be mandatory as well as ways to deal with the dissemination of technology and knowledge required for building them.

Beside technological progression, the emergence of new actors will considerably affect the conduct of military operations in CSW not just with regard to the employment of unmanned autonomous or remotely controlled assets. The growing diversity of actors – whether they are official, economic, private, or illegal users of the CSW environment – normally with non-congruent, often adverse interests, will increasingly shape the character of future conflicts and should be deliberately considered. MSA will be more than ever a key factor, especially in CSW, to be complemented by comprehensive activities in the cyber domain that will most likely further gain in significance.

Along with the rising complexity in the already challenging CSW environment, the command and control structures must be further adapted or developed. A flexible handling of command responsibilities is the prerequisite to tackle the needs of all factors culminating in the fascinating as well as demanding complexity of joint and combined operations in CSW. Therefore, this specific environment requires military commanders to be able to manage creatively and innovatively at higher levels of operational and tactical uncertainties. Beyond decisive knowledge on the operational specifics, this calls also for an extremely flexible and adaptable mind-set that masters the 'art of war'. The preparation of the CSW battlespace

through enhanced interactive and collaborative planning at all levels, as well as joint intelligence, interlocking of service capabilities, and deeper integration at lower echelons, will foster the flexibility and adaptability that is essential for operations in CSW.

The overall significance of the littorals for humankind has not changed throughout history; it may rather have increased and will most likely continue in that direction within the upcoming decades. Likewise, the military relevance of CSW – being part of the littorals – has always remained enormous. This did not change when the technological progression half a millennium ago allowed the use of the high seas. It may be disputed amongst historians whether there have been shifts in the main focus – CSW have doubtless always been and will remain in future, a prominent battlespace at the intersection of all military domains.

This raises the unquestionable need for the Alliance to provide superior capabilities that adequately meet the operational requirements of this very specific environment. Navies and the other services are well advised to keep a high degree of respective fighting capacity and readiness; in a nutshell:

- Pervasive **Interoperability**; in conjunction with a

- targeted, most effective use of **Synergy** – at all levels and among all services – should remain a cornerstone of NATO's future military campaigns and defence planning.

- Another key component is **Agility**, including the need for rapid and tailored reaction from all command levels involved in CSW-operations as well as the ability of world-wide deployment and employment.

- **Selectivity** must also be taken into account by providing multi-dimensional, scalable, and tailored capabilities offering a multi-layered and broad spectrum of options within an operation.

- Furthermore, **Survivability** is an everlasting requirement that may be enhanced through many, partially complementary or substitutive, ways such as a high degree of automation on a small, undetectable platform providing a maximum capacity for active as well as passive self-defence.

- Last but not least, as in the past, the needs with regard to **Sustainability** must be sufficiently met by providing logistic and administrative support in all required facets during all phases of an operation, including the relief and replacement of crews.

At the same time, it is likely that the trend to reduce the overall number of platforms will continue, inevitably raising the question: Is the required broad spectrum of sustained capabilities at hand? However, there may be two principle ways out that can be pursued individually but even better in parallel: First, mutual assistance amongst NATO members in providing required capabilities and second, to abandon the nexus of a special platform for specific tasks in concentrating various modular capabilities on one carrier in a common employment with autonomous systems. In that regard, this study may serve as a basic paper for a follow-on gap analysis and deduction of future required capabilities.

Appendices

A. Acronyms

A2/AD	Anti Access/ Area Denial
AAW	Anti-Air Warfare
AWW	Above Water Warfare
ACT	Allied Command Transformation
AMS	Allied Maritime Strategy
AOO	Area of Operations
ASuW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
ATP	Allied Tactical Publication
AUV	Autonomous Underwater Vehicle
C2	Command and Control
C4I	Command, Control, Communications, Computers, Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance
C-IED	Counter Improvised Explosive Device
CIMIC	Civil-Military Cooperation
COE	Centre of Excellence
COE CSW	Centre of Excellence for Operations in Confined and Shallow Waters
CSAR	Combat Search and Rescue
CSW	Confined and Shallow Waters
DOTMLPFI	Doctrine, Organization, Training, Material, Leadership, Personnel, Facilities, Interoperability
EEZ	Exclusive Economic Zone
EOD	Explosive Ordnance Disposal
EU	European Union
EU ISS	European Union Institute for Security Studies
FAC	Fast Attack Craft
FIAC	Fast Inshore Attack Craft
FP	Force Protection
FPB	Fast Patrol Boat
GPS	Global Positioning System
HA	Humanitarian Assistance
HQ SACT	Headquarters Supreme Allied Command Transformation

IED	Improvised Explosive Device
ISR	Intelligence, Surveillance and Reconnaissance
MDA	Maritime Domain Awareness
MIO	Maritime Interdiction Operations
MPA	Maritime Patrol Aircraft
MSA	Maritime Situational Awareness
MTF	Maritime Task Force
MUS	Maritime Unmanned Systems
MW	Mine Warfare
NATO	North Atlantic Treaty Organization
NEO	Non-Combatant Evacuation Operations
NGO	Non-Governmental Organization
NMCM	Naval Mine Counter-Measures
PMSC	Private Maritime Security Company
RPG	Rocket Propelled Grenades
RHIB	Rigid-Hulled Inflatable Boat
RMP	Recognised Maritime Picture
ROE	Rules of Engagement
SFA	Strategic Foresight Analysis
SLOC	Sea-Lines of Communication
SOF	Special Operation Force
SSM	Surface to Surface Missile
TBM	Tactical Ballistic Missile
TELAR	Transporter Erector Launcher and Radar
TTP	Tactics, Technics and Procedures
UAV	Unmanned Aerial Vehicle
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
USMC	United States Marine Corps
USV	Unmanned Surface Vehicle
UUV	Unmanned Underwater Vehicle
UVS	Unmanned Vehicle Systems
UWW	Under Water Warfare
WMD/E	Weapons of Mass Destruction/ Effects

B. Bibliography

Publications:

Allied Command Transformation; Strategic Foresight Analysis Workshop #2, Read Ahead Package, Budapest 13-14 November 2012

Allied Command Transformation; The Shared Perspective of the World in 2030 and Beyond, Themes and Drivers

Allied Command Transformation; Forging the Future, Strategic Foresight Analysis: Draft Future Security Implications, February 1, 2013

Allied Command Transformation; Strategic Foresight Analysis 2013 Report, Executive summary

Allied Maritime Strategy, 2011

Baer, George; One Hundred Years of Sea Power: The U. S. Navy, 1890-1990. Stanford, California: Stanford University Press

Compton's Encyclopedia

EU Institute for Security Studies; Report No 16: Enabling the future, European military capabilities 2013-2025: Challenges and avenues, Paris May 2013

ISPSW; Strategy Series: Focus on Defence and International Security. Maritime Security-Perspectives for A Comprehensive Approach. Issue No.222, April 2013

Joint Concept Note 1/12, Future 'Black Swan' Class Sloop-of-War, 2012

Kilcullen, David; Out of the Mountains - The Coming Age of the Urban Guerrilla, 2012

NATO 2012 Chicago Summit Guide, 2012

Ropp, Theodore; 'Continental Doctrines of Sea Power' in Edward M. Earle, Makers of Modern Strategy: Military Thought from Machiavelli to Hitler (Princeton: Princeton University Press, 1943)

Scharre, Paul; Center for a New American Security (CNAS), Robotics on the Battlefield, May 2014

United Nations Convention on the Law of the Sea (UNCLOS), 1982

U.S. National Intelligence Council; Global Trends 2030: Alternative Worlds, 2012

U.S. Naval Strategy in the 1990s Selected Documents NAVAL WAR COLLEGE PRESS Newport, Rhode Island, 2006

U.S. Navy; Way Ahead, Washington DC, 1991

U.S. Navy; From the Sea, Washington DC, 1992

U.S. Navy; Sea Power 21, Washington DC, 2002

U.S. Navy; Cooperative Strategy for 21st Century Sea power, Washington DC, 2007

Vego, Milan; Naval Strategy and Operations in Narrow Seas, 2003

Work, Robert O. & Brimley, Shawn; Center for a New American Security (CNAS), Preparing for War in the Robotic Age, Jan 2014

NATO Publications:

Allied Administrative Publication, (AAP 6), 2013

Allied Tactical Publication, (ATP 28), 2012

Allied Tactical Publication, (ATP 31), 2013

C. Annotations

[1] Topics can range from single warfare areas, e.g. Naval Mine Countermeasures, over complex (joint) littoral operations involving various warfare areas, e.g. Amphibious Operations, up to futuristic aspects such as the employment of Autonomous Underwater Vehicles in CSW or CSW-specific demands in the information engagement space as well as the spreading and use of new technologies.

[2] It was decided to focus on three examples. These consist of a **low intensity scenario**, an **asymmetric** and a **high intensity scenario**. They are of course only described very broad but nevertheless pointing out the essential characteristics of the operational environment they are dealing with. The scenarios are not included in this vision paper but are controlled by COE CSW D&ER –Branch.

[3] COE CSW Functional MoU, dated 3 October 2008.

[4] Milan Vego, Naval Strategy and Operations in Narrow Seas, 2003, pg. 13.

[5] Hypsometric is a scientific term relating to the measurement of heights.

[6] AAP 6, 2013

[7] This definition has been streamlined for Mine Warfare purposes.

[8] Population Reference Bureau report, "Ripple Effects: Population and Coastal Regions", Liz Creel, September 2003.

[9] NATO Allied Maritime Strategy, March 2011.

[10] According to the World Trade Organization, the global trade grew between 2000 and 2008 at an annual average rate of 12%.

[11] World Trade Organization, UNESCAP 2012.

[12] ISPSW Strategy Series, Focus on Defence and International Security, Maritime Security-Perspectives for a Comprehensive Approach. Issue No.222, April 2013.

[13] Ibid.

[14] NATO MSA Concept, 14 JAN 08 (MCM-0140-2007).

[15] US Joint Publication 1-02.

[16] CJOS COE, "A War-Fighting Concept for Littoral Sea Control", 2012.

[17] Milan Vego, Naval Strategy and Operations in Narrow Seas, 2003, pg. 33-40.

[18] Operational environment: A composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander. Also called OE. (JP 3-0)

[19] Hybrid Threats Description 1500/CPPCAM/FCR/10-270038 AND 5000 FXX/0100/TT-0651/SER: NU0040 Dated 25 August 2010: BI-SC Input for a new Capstone Concept for The Military Contribution to Countering Hybrid Threats dated (Paragraph 7); "those posed by adversaries, with the ability to simultaneously employ conventional and non-conventional means adaptively in pursuit of their objectives."

[20] ANTI-ACCESS (A2): Action intended to slow deployment of friendly forces into a theatre or cause forces to operate from distances farther from the focus of conflict than they would otherwise prefer. A2 affects movement to a theatre.

AREA-DENIAL (AD): Action intended to impede friendly operations within areas where an adversary cannot or will not prevent access. AD affects manoeuvre within a theatre. (Air-Sea Battle Concept).

[21] Two hundred years ago just 3 percent of the world's population lived in cities. Today, cities hold more than half of all the people on Earth. If this trend and pace continues, it is estimated that by 2050 over 70 percent of people will call cities home. (David Kilcullen - Out of the Mountains)

[22] The environment, factors, and conditions that must be understood to successfully apply combat power, protect the force, or complete the mission. This includes the air, land, sea, space, and the included enemy and friendly forces; facilities; weather; terrain; the electromagnetic spectrum; and the information environment within the operational areas and areas of interest. (JP 1-02).

[23] The continuation of tanker traffic during the 1984 - 1988 "Tanker War" in the Persian/ Arabian Gulf may serve as an exemplary proof of this thesis.

[24] Murphy, Martin, Littoral Combat Ship. An examination of its Possible Concepts of Operation, CSBA 2010, pg. 13-14

[25] According to ACTs SFA Report **Drivers** are the building blocks of future studies and other long term analyses.
A **trend** is a discernible pattern or a specified direction of change over time. An **implication** resulting from one or more particular trends that significantly affects the defence or security of one or more nations.
A **theme** is a collection of similar or related trends or a logical construct grouping related ideas.

[26] EU Institute for Security Studies. Report N: o 16: Enabling the future. European military capabilities 2013-2025: Challenges and avenues.

[27] QinetiQ, Lloyd's Register and University of Strathclyde Glasgow report: Global Marine trends 2030, 2013.

[28] US National Intelligence Council (NIC) report: Global Trends 2030, Alternative Worlds.

[29] harbouring more than 10 million people

[30] These changes will be seen in diverse areas ranging from resource exploration to biotechnology and manufacturing.
Allied Command Transformation, Strategic Foresight Analysis 2013 Report. pg. 25.

[31] http://en.wikipedia.org/wiki/Moore%27s_law.

[32] HQ SACT, Technology Trend Survey- Future Emerging Technology Trends, September 2011.

[33] Technologies could be used to degrade capabilities of the Alliance's political, military, economic, social, information and infrastructure systems. The proliferation of affordable conventional and unconventional capabilities will enhance the ability of a potential adversary to challenge the Alliance, particularly through Anti-Access / Area Denial (A2AD) weapons. Technology could be used to facilitate the organisation of social disturbance or high-impact terrorist attacks.
Allied Command Transformation, Strategic Foresight Analysis 2013 Report. pg. 26.

[34] Tim Benbow, The Future of Naval Conflicts, Maritime Security And Europe 2013 Aspen European Strategy Forum, October 25, 2013.

[35] Arctic Strategy, US DoD, November 2013, pg.2

[36] Center for a New American Security, Preparing for War in the Robotic Age, Robert O. Work & Shawn Brimley, January 2014.

[37] Strategy promulgated at NATO Summit 2010 in Lisbon

[38] "To achieve this, systems are to be developed that will have enhanced self-monitoring capabilities, such as self-diagnosis/self-adaptive/ healing platforms and networks.

- Self-protecting: To anticipate, detect, identify and protect against attacks from anywhere. Self-protecting components can detect hostile behaviours as they occur and take corrective actions to make themselves less vulnerable. The hostile behaviours can include unauthorised access and use, virus infection and proliferation, and denial-of-service attacks.
- Intelligent agents and remote (self) management features".

HQ SACT, Technology Trend Survey, Future Emerging Technology Trends, September 2011, pg.67-68.

[39] "Nanotechnology may support networks of very small persistent sensor that could be widely distributed through the operations area (smart dust). A wide variety of spectrally specific sensor applications is within reach of today's technology and only need implementation as ruggedized equipment is developed to perform some of the functions discussed above. The advantages of future electro-optic sensors will include high resolution imaging systems including adaptive optics for image stabilization and environment compensation that can exploit features of targets currently undetectable, greatly improve passive combat identification at longer stand-off ranges, specific biometric recognition by high resolution imaging (detects biometrics such as facial expressions, gesture, gait, height, invariant metrics such as pupil separation, etc.).

Spectrally-sensitive technologies will detect targets in cluttered background and under camouflage. These systems will be aided by automatic target recognition. They will be capable of detecting spectrally tailored particle tags that present strong, tailored spectral signatures that could be used in a variety of scenarios such as tagging of suspect vehicles at checkpoints/border crossings or tagging of individuals entering specific environments (room, base, etc.)."

HQ SACT, Technology Trend Survey, Future Emerging Technology Trends, September 2011, pg.37.

[40] For instance 3D-Printing allows an instant production of spare parts; thus it may enhance sustainability and flexibility as well as reduce logistic efforts respectively downtimes of systems up to whole assets.

[41] "The technology to create "swarms" of mini uninhabited vehicles, whether autonomous or remote controlled is becoming available. Groups of relatively simple robots, with relatively simple (and readily available) autonomous control systems (such as neural networks) have been shown to be able to co-operate to achieve quite complex goals".

HQ SACT, Technology Trend Survey, Future Emerging Technology Trends, September 2011, pg.48.

[42] "Autonomy is the ability of a machine to perform a task without human input. Autonomy can lead to several benefits, including: increased safety and reliability, improved reaction time and performance, reduced personnel burden with operational advantages or cost savings, the ability to continue operations in communications-degraded or -denied environments".
Paul Scharre, CNAS "Robotics on the Battlefield", May 2014, pg.12.

[43] "It would be utterly misleading to assume that 'asymmetric' is synonymous with 'non-state'. There is a long history of states taking advantage of asymmetric approaches, arguably even more at sea than on land. Even in the sailing era of war between the great powers, for example, France and then the young United States did not seek to context command of the seas with the Royal Navy but rather to inflict economic losses by raiding commerce. From the mid-19th century onwards the industrial revolution began to provide further options for those who wished to avoid taking on the leading naval powers at their own game. In the late 19th century, for example, there arose in France the 'jeune école', which argued that rather than build a battle-fleet to counter that of the Royal Navy, a better approach would be to focus on large numbers of small, agile torpedo boats which would overwhelm the powerful but ponderous British battle-fleet".
Theodore Ropp, 'Continental Doctrines of Sea Power' in Edward M. Earle, Makers of Modern Strategy: Military Thought From Machiavelli to Hitler (Princeton: Princeton University Press, 1943), pg.447-54.

[44] A conventional force applying asymmetric tactics is not really revolutionary; it happened in the past and will play a growing role in future developments.

[45] The increase in autonomous systems, even usable by small groups or single persons, can be ascribed to that diffusion.

[46] E.g. individual fighters sailing with appropriately shaped and equipped jet skis could disseminate data in real time globally resulting to an uncontrolled information environment.

[47] As a result this may significantly influence our mindset when conducting operations in CSW, especially due to:
- The intricate and manifold interdependencies of the various associated systems;
- The accelerating rates of growth in technology;
- Different perceptions of notions such as war-peace, military-civilian, public-private, and rather backward-looking conceptions of sovereignty (not yet adequately covering space-based surveillance systems, cyber tools and drone technologies).