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The Future of Maritime Surveillance in an Era of Contested Maritime Domains

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Overview

The Future of Maritime Surveillance in an Era of Contested Maritime Domains

Heiko Borchert

Abstract

Maritime surveillance is indispensable to guarantee maritime domain awareness. In turn, maritime domain awareness is a prerequisite for the effective use of the global maritime domain. Access to, maneuverability within, and use of the global maritime domain are increasingly contested. This is due to long-term trends such as shifts in global maritime trade patterns, rivalries prompted by the striving for resource supply security, demographic trends in key coastal areas, and maritime power projection by different actors. Ironically, though, members of the transatlantic community are hailing the freedom of the global maritime domain at a time when their naval capabilities are in relative decline due to global military overstretch, shifting policy preferences, and public debts that are out of control. This will create strategic problems for the transatlantic community, because long-term trends point towards the need to substantially expand maritime surveillance. In the future, it will be more and more important to explore what is going on in the deep sea, in the littorals, and on inland waterways. There is a fundamental need to come to terms with the maritime domain's dependence on other global commons, in particular space and cyberspace. Intelligence-based knowledge provision from various state and non-state sources must be fused into a comprehensive and recognized maritime picture, thus prompting new needs for comprehensive interagency interaction at national, regional, and international levels. In addressing all of these issues one question will be key: Given the tectonic shift of power from industrialized countries to a multi-polar international framework, who is going to set the rules, norms, principles, and standards relevant for maritime surveillance and thus command of the global maritime domain?

1 Introduction

People tend to realize the precious and yet transient nature of public goods only when they are in short supply. This is exactly what is happening today, as policy planners and decision-makers devote growing attention to what are called the 'global commons,' comprising four domains: sea, air, space, and cyberspace. The global commons are defined as "resource domains to which all nations have legal access,"[1] but the notion of equal access to the global commons is at risk. As the world is witnessing a shift of power from an international system with a clear leadership center to a more diffuse multipolar framework, the global commons are the domains where the nascent rules of international politics in the 21st century are being tested.

The global commons bind together domains that are indispensible for the free flow of goods, people, resources, and information that make up the backbone of a globalized world. Actors that are able to influence the quality and the direction of these flows exert strategic influence. This is the reason why the global commons are increasingly contested. Increased competition for the global commons results from the need to address several pressing global questions. These include the challenge of a growing world population, the need for access to fossil and mineral resources, the growing demand for food, and the likely impact of global climate change, to name but a few examples. At the heart of all these trends is the demand for sustainable solutions to meet the basic needs of modern societies. This struggle is directly linked to the management of the global commons. The national level of ambition envisaged to meet basic needs has a direct impact on the capabilities required to shape the global commons. In turn, existing capabilities to make use of the global commons determine the leeway each nation has to shape policy solutions commensurate with the respective requirements to satisfy its basic needs. As a consequence, unrestricted access to, maneuverability within, and use of the interrelated global commons lie at the heart of international politics in the 21st century. This will shape future requirements for maritime surveillance.

As Figure 1 illustrates, the extent to which each nation can use the global maritime domain very much depends on the nation's understanding of the characteristics and drivers that shape this environment. To this purpose, nations aim at establishing maritime domain awareness, which depends on maritime surveillance. Maritime surveillance includes all actions necessary for identification, monitoring, and understanding activities in the maritime domain and in all other domains relevant to the maritime environment. This requires a broad understanding of maritime use cases. In what follows, the paper will describe key developments in four categories: maritime transport, marine resources, maritime habitat, and maritime power projection. The key trends for each category will be discussed and reflections upon the likely impact on maritime surveillance presented.

[1] Susan J. Buck's definition quoted by Mark E. Redden and Michael P. Hughes, "Global Commons and Domain Interrelationships: Time for a New Conceptual Framework," *Strategic Forum* no. 295 (Washington, DC: Institute for National Strategic Studies, 2010), p. 1.

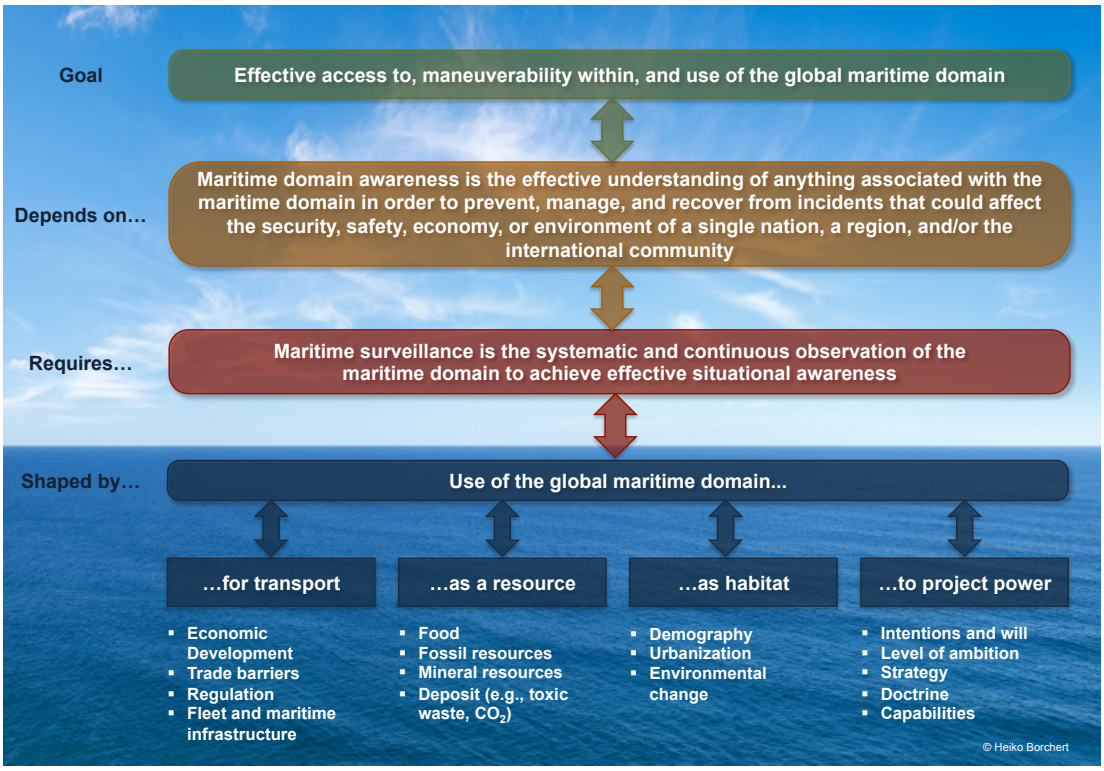


Figure 1: Analytical Framework

Based in parts on definitions in *National Plan to Achieve Maritime Domain Awareness for the National Strategy for Maritime Security* (Washington, DC: U.S. Government, 2005), p. 1; *Maritime Surveillance in Support of CSDP. The Wise Pen Team Final Report to EDA Steering Group* (Brussels: European Defense Agency, 2010), p. 47.

2 Maritime Transportation

Economic globalization and maritime transportation go hand in hand as around 90-95% of world trade is shipped. As a consequence, maritime transportation closely follows economic cycles. Several trends are particularly noteworthy:

- **Fossil energy resources**
  For decades the shipment of crude oil, petroleum products, and gas has dominated seaborne trade by volume. As energy preferences shift from fossil energy resources to renewables, it may be speculated how this trend will affect seaborne trade. Already today, Asian countries are the biggest importers of oil from the Persian Gulf.[2] As a consequence, they have an immediate strategic interest in the stability of the key maritime routes needed to guarantee uninterrupted flows of oil to their growing economies. For example, China receives 80% of its oil imports – supplied mainly by Saudi Arabia, Angola, Iran, and Oman – through the Strait of Malacca.[3] Thus, the long-term question is whether shifting energy preferences will drive Europe, the United States, and Asia apart as they follow diverging interests or bring them together to find common solutions to make seaborne energy-resource transport through the Indian Ocean safe and secure.

2 *Statistical Review of World Energy* (London: BP, 2010), p. 21.

3 Andrew S. Erickson and Gabriel B. Collins, "China's Oil Security Pipe Dream. The Reality, and Strategic Consequences, of Seaborne Imports," *Naval War College Review*, Vol. 63, No. 2 (Spring 2010), pp. 89-112; *China. Country Briefing* (Washington, DC: Energy Information Agency, 2011).

- **Maritime transport hubs and transport connections**

  When looking at the aggregate level of container terminal capacities, ship construction capacities, controlled fleets, and liner shipping connectivity, it becomes clear that Asia is the center of gravity of global maritime transport. Of the world's 20 busiest container terminals[4] 14 can be found in Southeast Asia, and among the world's 10 busiest container terminals, only two (Dubai and Rotterdam) are not located in Southeast Asia.[5] Whereas countries from the transatlantic community and Southeast Asia share ranks among the top 10 of the world's best-connected countries, China, Hong Kong, and Singapore lead the list. In 2010 twice as many ships called at ports in China than at ports in the Netherlands or Germany, Europe's best-connected countries.[6] These developments point towards a global maritime freight transportation system in which Asian markets play the key role. As Jean-Paul Rodrigue[7] pointed out, the emergence of Brazil, India, and China as economic power engines could lead to a new maritime connection in the Southern Hemisphere directly linking the respective markets. Russia, in turn, could benefit from the opening of the northern passage across the Arctic, as this route is expected to cut transport distances significantly, in particular for shipments between Europe and Asia.[8] In this regard it is more than noteworthy that Russia operates by far the world's largest fleet of icebreakers, including nuclear-powered icebreakers; this is an asset that is missing from the arsenal in the United States, Canada, China, Norway, or Denmark, which all claim access to the North Pole.[9]

- **Inland waterways**

  Another important aspect is the role of inland waterways, which make an essential contribution to prosperity in well-developed economic regions. In contrast, Brazil uses only around one-fourth of its navigable inland waterways for economic purposes but wants to double their share of the overall transportation mix by 2025.[10] This raises several questions with regard to the multifold use of inland waterways for transport and hydropower generation and to the use of vessel traffic management systems for inland waterways. Brazil's example makes it clear that increasing reliance on inland waterways to advance economic prosperity will also prompt additional maritime surveillance needs. Inland waterways connect regions in the hinterland with international sea lanes and are thus a vital link in the global maritime supply chain. But if surveillance and control of these inland waterways wane, as is the case in the Niger Delta, for example, the respective nations will be deprived of an important instrument to generate local prosperity. For this reason, the international community should pay more attention to inland waterway surveillance in developing countries.

4 In terms of 20-foot equivalent units.

5 *Review of Maritime Transport 2010* (Geneva: UNCTAD, 2010), p. 97

6 "Trends in liner shipping connectivity," *UNCTAD Transport Newsletter,* No. 47 (Third Quarter 2010), pp. 5-6.

7 Jean-Paul Rodrigue, "Maritime Transportation: Drivers for the Shipping and Port Industries," Paper Commissioned for the Experts' Session on Innovation and the Future of Transport, Paris, 26 January 2010, http://www.internationaltransportforum.org/Pub/pdf/10FP02.pdf (accessed 21 June 2011).

8 Svend Aage Christensen, *Are the northern sea routes really the shorter?* (Copenhagen: DIIS, 2009).

9 *The World Icebreaker and Icebreaking Supply Vessel Fleet* (Helsinki: Baltic Icebreaking Management, 2008).

10 Paulo Sérgio Passos, "Logistic Infrastructure Scenario in Brazil," Presentation, InnoTrans 2010, Berlin, 21 September 2010.

- **Maritime transport technology**
  Finally, maritime transport technology should also be kept in mind. Technologies that help advance logistics efficiency will become even more important in the future, since competition between harbors is likely to grow. Several options are feasible. Advanced use of information and communication technology could help drive the digitization of global logistics, thus making it easier to track and trace goods. This is also relevant for regional and global security, of course, as will be discussed below. Materials technology is of increasing importance for shipbuilders, because material innovation can help reduce energy consumption and CO_2 emission by cargo ships. In addition, it could be considered whether the use of automatic and unmanned systems could help improve operations in congested coastal zones and harbors. For example, unmanned systems could be used for commercial logistics seabasing, thereby providing an opportunity to load and unload cargo vessels without the need to enter densely populated harbor infrastructures. Automatic or semi-automatic platforms could also provide offshore refueling stations, thus reducing the need for ships to travel through dangerous waters. And thought should be given to the idea of using unmanned maritime cargo systems along preconfigured routes to speed up short-distance maritime transport and to boost trade along coastal hubs.

These maritime transportation trends could result in several additional maritime surveillance requirements:

- **Promote pan-regional public-private information exchanges for global supply chain surveillance**
  The global maritime supply chain, which consists of many different stakeholders, is part of a global multimodal supply chain that connects maritime transport with road and railway networks and with commercial air transport. If current trade projections materialize, multimodal transport will become even more important to handle global trade flows. To advance the security of global supply chains, more information sharing between public and private stakeholders will be needed to avoid security breaches and prevent the abuse of global logistics for illicit activities. This puts a premium on the quality of information sharing. Two aspects are particularly important. First, there is a need for comprehensive risk assessments along the global supply chain to determine which components are most vulnerable and how dangerous goods could be passed along different modes of transport. Second, the public sector should be engaged in creating trustworthy information exchange environments. Public agents could act as honest brokers to mitigate the risk of information exchange between corporate actors that are direct competitors and might therefore be reluctant to share sensitive information.

- **Develop stand-off screening technologies to detect illicit goods**
  Technology proliferation, breaches of international sanctions, and the transfer of illicit goods are some of the most pressing security challenges directly affecting maritime trade. Given high maritime transport volumes, cargo screening at points of embarkation and disembarkation runs into practical problems. Therefore, another layer of safety and security controls on sea while ships are approaching harbors might be needed. News reports indicate that radar technology can be used to scan the cargo of cargo planes mid-flight.[11] This kind of technology could be used at sea as well, if the salty and humid physi-

[11] "Israeli observation," *Intelligence Online* (19 January 2011), p. 4.

cal environment does not negatively affect the performance of the technology. In combination with air and space-based assets this could provide an opportunity to establish standoff screening technologies and thus push maritime surveillance to new levels.

- **Assess surveillance needs resulting from the use of autonomous systems**
  The commercial use of unmanned systems at sea would very likely give rise to demands similar to the demands addressed by the aerospace industry to make sure that unmanned aerial systems can operate alongside conventional air traffic. Concepts of operation for the use of unmanned systems at sea will have to be complemented with technical solutions for detection, identification, and tracking of these platforms. Sense and avoid capabilities will be needed to prevent collisions. Legal questions pertaining to the certification of unmanned under/above-water systems would have to be addressed as well. Finally, reliance on these systems would require a networked approach to maritime traffic management; information security would need to receive priority treatment (see section 5 below).

- **Consider technology pull-through for surveillance in different maritime environments**
  The growing use of inland waterways might prompt demands for sophisticated solutions to provide maritime surveillance in a domain that differs significantly from the high seas, for which many available technologies have been developed. For example, mud and sandbanks in a riverine environment could pose challenges for sonars and sensors that have up to now been used in blue waters. Similarly, surveillance technology for use up in the High North might have to withstand very tough environmental conditions. Addressing these challenges also creates interesting opportunities for public-private research studies aiming to assess the feasibility of technology pull-through from one maritime environment to another.

3 Marine Resources

The global maritime domain plays an increasingly important role as a provider of many different resources. Access to these resources and access to the maritime transport routes needed to bring these resources to consumer markets will be one of the key trends shaping the maritime interests of various countries and thus also their preferences to build up maritime capabilities needed to protect their interests.

Figure 2 gives an overview of some of the most important marine resource areas and puts them in context with other security-relevant issues, such as fragile governance structures and the scope of pirate activities. Against this background, the following facts and trends are worth considering:

- **Fish stock**
  Fish continues to be a major source of protein in the diet for large parts of the world population. The world supply of fish and aquaculture has grown steadily, reaching 145 million tons in 2009 after roughly 130 million tons in 2000. From 1998 to 2008, the value of exported fish and fishery products doubled from around $51 billion to around $102 billion. But global fish stock is in danger. Today, around 50% of the world's fish stock is fully exploited, and more than 30% is overexploited. Only 15% of global fish stock is underexploited or moderately exploited. Climate change is creating additional problems.

Extreme weather conditions could affect the distribution of fish, habitat size, and productivity, thus worsening fishermen's perspectives. Illicit fishing aggravates these problems even further. Maritime disputes seem to make things even worse, as news reports about illegal fishing activities off the coast of Libya in early June 2011 showed.[12]

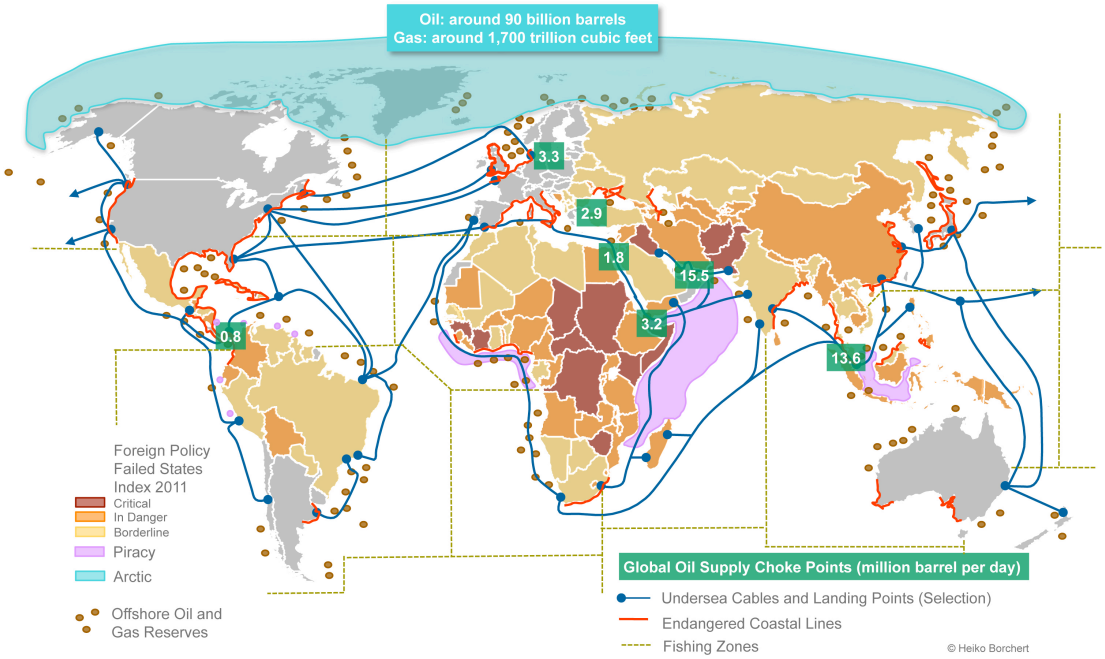


Figure 2: Key Resources and Risk Areas in the Maritime Domain

Sources: *Statistical Review of World Energy; The DCDC Global Strategic Trends Programme 2007-2036* (Shrivenham: Development, Concepts, and Doctrine Centre, 2007); *World Transit Chokepoints* (Washington, DC: Energy Information Agency, 2011), "The Failed States Index 2011", http://www.foreignpolicy.com (accessed 21 June 2011); "IMB Live Piracy Map 2011," http://www.icc-ccs.org/piracy-reporting-centre/imb-live-piracy-map (accessed 21 June 2011); "Fishery Resources Monitoring Resource," http://firms.fao.org/firms/resource/search/en (accessed 21 June 2011); Ronald O'Rourke, *Changes in the Arctic: Background and Issues for Congress* (Washington, DC: Congressional Research Service, 2010); *Global Submarine Cable Map* (Washington, DC: Telegeography, 2010); Sarah Zierul, *Der Kampf um die Tiefsee. Wettlauf um die Rohstoffe der Erde* (Hamburg: Hoffman & Campe, 2010).

- **Offshore reserves**

  Given the world's growing hunger for fossil energy resources, offshore reserves are becoming more and more important. Overall, it is hard to provide figures for the total share of global offshore oil and gas reserves. In the European Economic Area, for example, around 90% of the region's oil and 60% of its gas production originates from offshore.[13] But whereas Europe's offshore fossil reserves are in decline, new reserves are found in other regions of the world. Estimates assume that the High North could harbor around 90 million barrels of oil (about the same as the proven reserves of the United Arab Emirates) and around 1,700 trillion cubic feet of natural gas (about the same as the proven reserves of Russia). Approximately 84% of these reserves are offshore.[14] Energy resource-related claims by different countries also collide over access to the Spratly Islands and gas

12 *The State of World Fisheries and Acquaculture* (Rome: FAO, 2010), p. 4, 35, 52; *The State of World Fisheries and Acquaculture* (Rome: FAO, 2002), p. 4; "Hot Pursuit of Tuna Seiner Along Qaddafi's Line of Death," *Sea Shephard Press Release,* 5 June 2011, http://www.seashepherd.org/news-and-media/news-110605-1.html (accessed 21 June 2011).

13 Facing the challenge of the safety of offshore oil and gas activities, COM(2010) 560 final, Brussels, 12 October 2010, p. 2

14 O'Rourke, *Changes in the Arctic.*

reserves in the eastern Mediterranean. The latter is a particular case, because exploiting the gas fields off the coast of Israel and Lebanon has not only prompted rivaling claims by the two respective countries but also by Hezbollah.[15] In addition to conflicting claims, technical aspects of offshore activities need to be taken into account. Whereas Deepwater Horizon was operating oil drills at around 1,500 meters below the waterline in the Gulf of Mexico, the Petrobras Company will have to drill down 7,000 meters to exploit huge oil fields off the Brazilian coast.[16] This obviously raises questions with regard to the safety of the technical installations used for these challenging operations.[17] Additional energy-related offshore activities relevant for maritime surveillance include plans for small offshore nuclear power plants that could be installed on the seabed and the construction of gigantic offshore wind parks that can cause problems for radars and submarines.[18]

- **Choke points**
  The global oil supply choke points in Figure 2 are another serious concern. Rivalries between different states and threats to block key choke points, such as the Strait of Hormuz or the Strait of Malacca, affect not only maritime trade but also international commodity prices. In addition, critical passages such as the Strait of Bosporus raise the specter of large-scale incidents at the heart of a multimillion city that would cause major casualties and significant environmental damage. Irrespective of the world's energy preferences, key choke points like the Strait of Hormuz are very likely to remain hot spots for the near future, because capabilities to control the strait or disrupt the control of the strait can be used as political currency.

- **Undersea communication cables**
  Finally, the global maritime domain is home to one of the world's most important but most often overlooked infrastructures: undersea communication cables. Undersea communication cables are absolutely vital, because they handle almost all of the world's intercontinental digital traffic. With global bandwidth demand on the rise, undersea communication cables will grow in importance. Vulnerability of these cables at the transition from deep water to the landing points is a major concern, since most of these landing points are located in areas with heavy maritime traffic. In addition to natural hazards (e.g., earthquakes), technical failures, and interruptions caused by negligence (e.g., anchors), undersea cables have also become the object of theft, and undersea cable repair ships are also possible targets for pirates.[19]

15 Michael Ratner, *Israel's Offshore Natural Gas Discoveries Enhance its Economic and Energy Outlook* (Washington, DC: Congressional Research Service, 2011).

16 "Petrobras verweigert mehr Sicherheit. Brasilianischer Ölkonzern hält seine Standards bei Tiefseebohrungen für ausreichend," *Financial Times Deutschland* (12 January 2011), p. 7.

17 For an impression of the technological challenges related to subsea energy-resource exploitation, see: http://innovate.statoil.com/challenges/Pages/SubseaTechnology.aspx (accessed 21 June 2011).

18 "Deep sea fission," *World Nuclear News* (20 January 2011); "Cassidian improves performance of air traffic control radars in eliminating wind turbine interference," *EADS Press Release* (8 June 2011); "'Leuchtturm' für U-Boote," *Thales Instruments Press Release* (18 May 2011).

19 Karl F- Rauscher, *Proceedings of the Reliability of Global Undersea Cable Communications Infrastructure* (New York: IEEE Communications Society, 2010); *Submarine cables and the oceans: connecting the world* (Lymington/Cambridge: International Cable Protection Committee/United Nations Environment Program World Conservation Monitoring Center, 2009).

Access to and exploitation of marine resources will shape maritime interests in the 21st century. As a consequence, all of the above mentioned activities should receive utmost attention when defining future maritime surveillance capabilities. Among other things, the following actions could be taken into account:

- **Advance underwater and deep sea situational awareness**
  In light of expanding offshore activities, a comprehensive, recognized maritime picture will require the systematic and continuous monitoring of all relevant above-water and underwater activities. This will pose challenges. So far, underwater situational awareness has most often been restricted to operations like anti-submarine warfare or mine clearance. This is not enough. When considering the exploitation of marine resources in contested areas, a situational picture of underwater exploitation activities could create transparency and thus advance confidence between the parties involved.

- **Think about protection concepts for key underwater infrastructures**
  If conflicting claims about access to offshore oil and gas reserves are a harbinger of possible future conflicts, then it should be taken into account that critical underwater infrastructures are possible targets for attack. These attacks would serve several purposes. The sinking of Deepwater Horizon made it clear that environmental damage is significant. Public outrage caused by the destruction of vulnerable ecosystems can escalate and lead to the loss of trust and confidence in the public and private actors involved in handling the crisis. In addition, there are financial losses due to the damage of costly infrastructures and revenue losses due to installations that are out of function. One can speculate about the motives, resources, and expertise of possible perpetrators, but it seems quite obvious that protection against a comprehensive set of risks (e.g., natural hazards, technical vulnerabilities, use of weapons) should be taken seriously. As many underwater infrastructures would most likely affect the interests of several coastal parties, the need to manage the respective risks could create opportunities for cooperation.

- **Expand capabilities to monitor, track, and trace underwater activities**
  Underwater situational awareness requires capabilities to monitor, track, and trace underwater activities. These multipurpose capabilities would serve different ends: They would play an eminent role in advancing environmental protection, for example, by providing information about deep sea drilling, and could also help deter and prevent illegal fishing. Tracking and tracing underwater activities could also play a key role in improving the protection of undersea communication cables in transit from deep waters to landing points. Finally, underwater tracking and tracing would also be of use for the International Seabed Authority, whose task is to administer mineral resources in the international seabed.

- **Consider cooperative monitoring operations for contested Exclusive Economic Zones**
  An exclusive economic zone (EEZ) is a vital geostrategic area covering the transition between a state's territorial sea and the high seas. Current estimates assume that EEZs make up around one-third of the world's seas.[20] The problem is that these zones are likely to grow, as more and more countries engage in EEZ-related claims of sovereignty, security,

[20] Geoffrey Till, *Seapower. A Guide for the Twenty-First Century* (London: Routledge, 2009), p. 302; James Kraska, *Maritime Power and the Law of the Seas. Expeditionary Operations in World Politics* (Oxford/New York: Oxford University Press, 2011), pp. 4-7.

and environmental protection. As James Kraska showed, these claims are not only a source of instability in the international law of the sea but also serve as a means to limit the effectiveness of expeditionary sea power by regulating military activities in the EEZs.[21] Therefore, maritime surveillance should put particular emphasis on monitoring developments in EEZs. All of the above activities help accomplish this task. But since there is also the risk that information gathered from these activities will be misused by coastal states to exclude others from using the EEZs, thought should be given to deploying international monitoring operations for particularly contested EEZs. Joint monitoring operations involving the navies, coast guards, law enforcement agencies, environmental protection agencies, and other stakeholders could help advance confidence building. Given their traditional diplomatic role, navies could lead by example and conduct more joint monitoring operations in waters of strategic importance (Figure 2). In parallel, military diplomacy could be stepped up along key maritime supply routes. This would also support other policy goals. For example, unrestricted access to maritime supply routes is an important precondition for effective development policy in the 21st century. Navies and development agencies could thus join forces in stabilizing maritime transport hubs in important coastal zones.

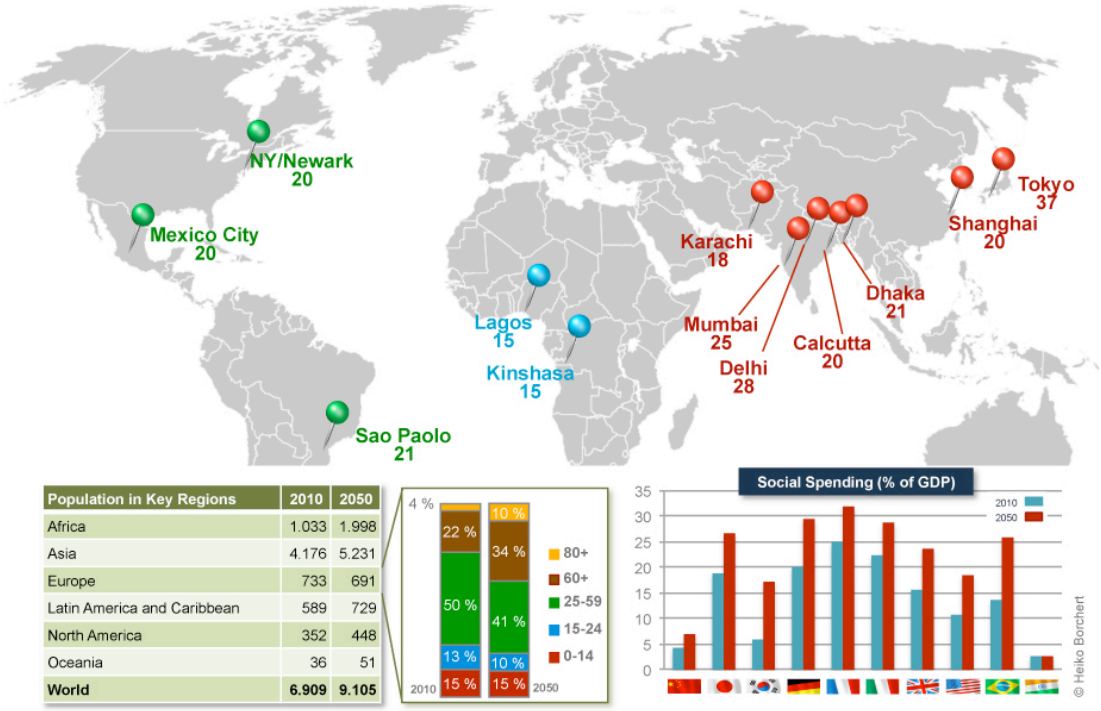
4 Maritime Habitat

Already today, around 70% of the world's population lives in coastal regions. Given current projections of future population growth, this concentration is very likely to grow, thus increasing the pressure on the littorals. In order to assess future maritime surveillance requirements, the following trends should be taken into account:

- **Demographics**
  Demographic development has an ambivalent effect on the maritime domain. As Figure 3 shows, the world population is projected to rise from around 7 billion right now to over 9 billion in 2050, with the most significant increases taking place in Asia and Africa. This will put an extra burden on rapidly evolving megacities. Most of them can be found along the world's busiest coastal zones. Megacities are attractive hubs of economic prosperity, and they provide access to global maritime supply chains. But they are also at risk due to the inflow of people, inadequate infrastructures, and activities by violent non-state actors, such as gangs and organized crime (see section 5 below). As a consequence, fragile megacities mixed with state-level insecurity across the world's most important coastal zones are very likely to become the next big security issue for which the international community should prepare. In contrast, in Europe demographic change might come with different consequences for maritime business. Since Europe's population is shrinking and growing older, there might be a shortage of seafarers and qualified officers. This, in turn, could affect compliance with existing environmental, safety, and security regulations on board ship and perhaps also in busy harbors.[22] In addition, increases in social spending due to demographic changes will cause public spending shifts, most likely to the detriment of maritime capabilities.

21 Kraska, *Maritime Power and the Law of the Seas,* p. 9, 13, 18.

22 *OPTIMAR: Benchmarking strategic options for European shipping and for the European maritime transport system in the horizon 2008-2018* (Västra Fölunda: Lloyd's Register Fairplay, 2008), pp. 199-200.



Population in Key Regions	2010	2050
Africa	1.033	1.998
Asia	4.176	5.231
Europe	733	691
Latin America and Caribbean	589	729
North America	352	448
Oceania	36	51
World	**6.909**	**9.105**

Figure 3: Megacities in 2025 (million inhabitants)

Sources: Marko Mrsnik, Global Aging 2010: An Irreversible Truth (London: Standard & Poors, 2010); World Population Prospects: The 2008 Review (New York: United Nations, 2009), p. 7; World Urbanization Prospects: The 2009 Revision (New York: United Nations, 2009).

- **Spatial planning**

  Another aspect, which is closely related with demographic change, is spatial planning. Land-based growth opportunities for megacities are limited. As a result, megacities could expand offshore. There are many examples of large cities establishing artificial land zones into the littorals to create more space for transportation infrastructure, such as airports. Going one step further, the Japanese construction company Shimizu envisions "Green Floats," which are urban villages built on floating platforms that could provide a new home for up to 50,000 people per platform. Several platforms could be tied together to create floating cities at sea. Green Floats could also provide an option for island states threatened by the risk of rising sea levels.[23]

- **Climate change and rising sea levels**

  Climate change has been identified as a threat multiplier that is likely to contribute to instability in different regions of the world.[24] In general, we can assume that the impact of climate change on domestic stability will have an influence on the international behavior of states.[25] What matters most in terms of future maritime surveillance requirements is the impact of climate change on sea levels. Although there are still significant uncertainties in projections of sea level rise, the Intergovernmental Panel on Climate Change con-

23 "Green Float: The Environmental Island," http://www.shimz.co.jp/english/theme/dream/greenfloat.html (accessed 21 June 2011).

24 *National Security and the Threat of Climate Change* (Alexandria: CNA Corporation, 2007).

25 Jeffrey Mazo, *Climate Conflict: How global warming threatens security and what to do about it* (London: Routledge, 2010), Cleo Paskal, *Global Warring. How Environmental, Economic, and Political Crises Will Redraw the World Map* (New York: Palgrave Macmillan, 2010).

cluded that "sea level rise is one of the longest-term consequences" of climate change.[26] Many coastal areas are vulnerable to rising sea levels (see Figure 2, red line), but it has been estimated that "75% of all people living in areas vulnerable to sea level rises are in Asia, with the poorer nations most at risk."[27] Refugee flows and internal displacement of people might be the consequences, which will increase the burden on megacities described above. In addition, rising sea levels will impact the economy, as there are key infrastructure components in coastal zones. For example, China's most important terminals for the supply of liquefied natural gas (LNG) are on the east coast. Approximately 95% of Nigeria's export earnings are from supplying oil and gas. These sales account for around 65% of the Nigerian government's revenues. And in the United States, the Louisiana Offshore Oil Port receives 13% of the country's oil imports and is connected to 50% of the country's refining capacities.[28]

- **Pollution**
  Finally, pollution of the ocean is getting worse. There are several risks, including the release of sewage and wastes, chemical pollutants, spillover effects from exploiting fossil energy resources, and the uptake of plastics by fauna.[29] Overall, research suggests "resilience of the ocean to climate change impacts is severely compromised by the other stressors from human activities, including fisheries, pollution and habitat destruction."[30] Maritime surveillance should therefore incorporate initiatives to advance ecosystem-based management of marine and coastal areas.[31]

Some ideas discussed in sections 2 and 3 will be of use in tackling the above-mentioned challenges. Additional thought should be given to the following options:

- **Develop comprehensive approaches to improve the resilience of megacities in coastal zones**
  Maritime surveillance must take into account threats to the littorals, because it will be much more difficult to address security risks from sea if coastal zones tumble towards instability. However, there is no direct way to improve the resilience of coastal zones. Research findings even suggest that there may be counterintuitive effects: The lack of appropriate governance can be interpreted as a key root cause of many problems that contribute to maritime disorder. But there are situations when even criminal gangs benefit from improved governance, "as access to markets and infrastructure improves and protection of the loot becomes less costly."[32] As a consequence, there is a need for a Comprehensive Approach to address the very specific requirements of megacities in coastal

26 *Workshop Report on the Intergovernmental Panel on Climate Change Workshop on Sea Level Rise and Ice Sheet Instabilities* (Bern: IPCC Working Group I Technical Support Unit/University of Bern, 2010), p. 1.

27 *The State of Asian Cities 2010/11* (Fukuoka: United Nations Human Settlements Program, 2010), p. 184.

28 "Louisiana Offshore Oil Port: History," http://www.loopllc.com/ (accessed 25 June 2011); *China. Country Briefing*; *Nigeria. Country Briefing* (Washington, DC: Energy Information Agency, 2011)

29 *Implementing the Global State of the Oceans Report* (Oxford: International Program on the State of the Ocean, 2008), pp. 16-17.

30 Alex Rogers and Dan Lafolley, *International Earth system expert workshop on ocean stresses and impacts* (Oxford: international Program on the State of the Ocean, 2011), p. 6.

31 *Taking Steps toward Marine and Coastal Ecosystem-Based Management – An Introductory Guide* (Nairobi: United nations Environment Program, 2011).

32 Olaf J. De Groot, Matthew D. Rablen, and Anja Shortland, "Gov-aargh-nance – even criminals need law and order," paper presented at the Royal Economic Society Annual Conference, London, 18-20 April 2011.

zones. It should be considered whether an international initiative supported by, for example, the United Nations Environment Program, the United Nations Agency for Human Settlements, the International Maritime Organization, and the World Trade Organization in cooperation with the European Union, the North Atlantic Treaty Organization, and important regional organizations from Africa, Latin America, and Southeast Asia could provide a platform large enough for all relevant public and private actors to establish a stake in this important issue.

- **Advance early warning capabilities for coastal zones**
  Early warning is important to improve coastal zone resilience. As extreme weather conditions are more likely in the future, there is a need for more resilient early warning infrastructures that survive even demanding environmental incidents. Mobile, ad hoc, and self-healing sensor networks could provide a valuable option; attention should be focused on smart multi-purpose sensors that could be used for communication, data transfer, monitoring of activities, and change detection. In addition, it can be expected that the demand for hydrographic information will increase as underwater activities expand. For this reason, collecting data and information on water depths and structures of the seabed should receive more attention. This also creates opportunities for multinational cooperation.

- **Be aware of challenges to existing legal regimes**
  Existing maritime law will be challenged, as excessive claims beyond the EEZs perfectly illustrate. This trend could be aggravated by ambitious plans for maritime urbanization and the use of inhabited maritime platforms as floating villages. Those countries interested in guaranteeing the freedom of the seas and the freedom of navigation would be well advised to closely monitor maritime sovereignty claims by resource-hungry and densely populated countries, since they are the most likely challengers of the maritime status quo.

5 Maritime Power Projection

Power projection and the use of the maritime domain are strongly intertwined. Future trends suggest that traditional ways of projecting maritime power are at risk. This will have fundamental implications for maritime surveillance. In addition to excessive EEZ claims, the following challenges should be addressed:

- **Strategic maritime capabilities**
  More and more regional powers are increasing their investments in strategic maritime capabilities. China and India are the two most obvious examples. Both are putting an emphasis on expanding their submarine fleets and investing in aircraft carriers. Both nations have also greatly expanded naval areas of operations, among others, by conducting simultaneous naval operations in the Mediterranean and in the Indian Ocean. China has in addition put a focus on anti-access and area denial (A2/AD) capabilities, C4ISR,[33] space-based assets, and information warfare, thus significantly expanding the country's ability to deny an opponent freedom of maneuver.[34] Other countries are following this pattern.

[33] Command, Control, Computers, Communication, Intelligence, Surveillance, and Reconnaissance.

[34] Roland O'Rourke, *China Naval Modernizaton: Implications for U.S. Navy Capabilities – Background and Issues for Congress* (Washington, DC: Congressional Research Service, 2010); Richard Scott, "Joining the Club. Briefing: Carrier Air Power – China and India," *Jane's Defence Weekly* (19 January 2011), p. 5; Geoffrey Kemp, *The East*

Australia's 2009 defense white paper foresees a "more potent" Navy able to conduct undersea warfare, anti-submarine warfare, and surface maritime warfare. The country will significantly increase its submarine fleet by 2030 and invest in unmanned underwater systems.[35] Brazil's 2008 national defense strategy is illuminating, as it explicitly tasks the country's navy to protect oil platforms and naval and oil facilities and to respond to threats against sea lanes. Brazil also wants to establish a powerful submarine fleet and is even considering the purchase of nuclear-powered submarines to protect offshore oil fields.[36] In contrast, many European countries are cutting back their naval assets due to budgetary problems.

- **Technology proliferation**
  These investment priorities must be interpreted in light of the increasing danger of technology proliferation, in particular with regard to A2/AD capabilities. Ready-to-use containerized A2/AD weapon systems that can be operated from maritime vessels, thus providing state and non-state actors the ability to expand their naval zone of influence, further aggravate this risk. In addition, technology transfer is proving to be increasingly ambivalent. Almost all of the aspiring development countries have made technology transfer a prerequisite for market access. As a consequence, defense suppliers' export prospects depend on their readiness to share technologies. However, this is problematic, if technology transfer to the end user cannot be controlled, and it opens the door for technology proliferation to other countries and non-state actors.

- **New partnerships**
  In parallel to global power shifts we are also witnessing new cooperative ventures between countries with distinct regional and global maritime interests. One example is the most recent agreement between France and Russia to provide the Russian Navy with amphibious assault ships. The deal also seems to include technology transfer and could be complemented with other cooperative projects in the future. Another significant initiative is the training of Chinese Navy pilots on Brazilian aircraft carriers,[37] which should also be seen in light of China's interest in Brazilian offshore oil reserves. Cooperation in itself is not a problem, but it can create confusion if changing cooperation patterns make it more difficult to predict a nation's behavior.

- **Interdomain relations**
  Additionally, thinking across all relevant domains to advance maritime surveillance is indispensible, because "*intradomain* military operations are increasingly dependent on *interdomain* dependencies."[38] For example, naval operations depend on space-based assets and access to cyberspace. Space-based assets are needed for all sorts of communication and data exchange and for navigation; access to cyberspace is indispensable to

Moves West. India, China, and Asia's Growing Presence in the Middle East (Washington, DC: Brookings, 2010); *Military and Security Developments Involving the People's Republic of China 2010. Annual Report to Congress* (Washington, DC: Department of Defense, 2010); Toshi Yoshihara and James R. Holmes, *Red Star over the Pacific. China's Rise and the Challenge to U.S. Maritime Strategy* (Annapolis: Naval Institute Press, 2010).

35 *Defending Australia in the Asia Pacific Century: Force 2030* (Canberra: Department of Defence, 2009), pp. 70-74.

36 *National Strategy of Defense. Peace and Security for Brazil* (Brasilia: Ministry of Defense, 2008), pp. 20-22; "Brazil to protect oil fields with nuclear sub: minister," *Agence France Press* (6 May 2008).

37 Kai Thaler, *Using BRIC to build at sea: The Brazil-China aircraft carrier agreement and shifting naval power* (Lisbon: Portugese Institute of International Relations and Security, 2010).

38 Redden/Hughes, "Global Commons and Domain Interrelationships," p. 2.

make sure that these exchanges are safe, secure, and reliable. In the future, maritime surveillance must prepare for deliberate action by state and non-state actors to disrupt important lines of communication; hide, spoof, and reroute digital traffic; or take out vital maritime infrastructures.

- **Non-state actors**
  Finally, non-state actors also have an interest in using the maritime domain for their own interests. Today, pirates are the most prominent non-state maritime actors. Given data limitations, it is difficult to assess the global costs caused by piracy, but studies assume that annual global costs could range from around $5-16 billion.[39] Organized criminals engaged in illicit activities such as human trafficking and smuggling of heroin, cocaine, firearms, and counterfeit products also make a lot of money by exploiting maritime disorder.[40] The fact that organized crime and piracy come together in certain littoral hotspots has caused concern that terrorists could become involved as well. This could create a situation where all three rely on each other for operational support, funding, and the joint provision of support infrastructures.[41] In sum, the presence of non-state actors in the maritime domain makes operations in contested and congested littorals even more challenging and will generate additional requirements.

In terms of future maritime surveillance requirements, these trends suggest that there will be an increased need to push intelligence cooperation to new levels and to systematically address dependencies between the maritime domain and other global commons. That said, four aspects deserve special attention:

- **Promote systematic and continuous all-source information fusion to counter adversarial A2/AD strategies**
  Keeping track of a plethora of different activities in the maritime domain will become increasingly difficult. This prompts an immediate need for improved all-source information fusion. Several avenues should be pursued. First of all, supply chain monitoring to detect unwanted adversarial access to important A2/AD technologies becomes vital. This requires closer public-private information sharing to assess the credibility of all partners involved in the respective supply chain. In the maritime domain, monitoring adversarial build-up of A2/AD capabilities is likely to create further needs for improved and expanded reconnaissance capabilities. Geospatial assets are already beefed up to monitor resource-rich areas and keep track of vessels. Given the fact that some countries want to hide critical maritime infrastructures used for A2/AD purposes, ground-penetrating capabilities will gain in importance. Advancement of deep-sea capabilities to monitor the deployment of underwater platforms over large ocean areas should also be considered.[42]

- **Address the maritime domain's cyber Achilles heal**
  As pointed out above, the growing reliance on space and cyberspace is a particular concern, because the accidental or deliberate loss of these assets would seriously hamper

39 *The Economics of Piracy. Pirate Ransoms and Livelihoods off the Coast of Somalia* (Dubai: Geopolicity, 2011); *Anna Bowden, The Economic Costs of Maritime Piracy* (Louisville: One Earth Future Foundation, 2010).

40 *The Globalization of Crime. A Transnational Organized Crime Threat Assessment* (Vienna: United Nations Office on Drugs and Crime, 2010).

41 Martin N. Murphy, *Small Boats, Weak States, Dirty Money. Piracy and Maritime Terrorism in the Modern World* (London: Hurst & Company, 2009).

42 Richard Scott, "DARPA calls for deep sonar ASW concepts," *Jane's Defence Weekly* (19 January 2011), p. 5.

maritime domain awareness. Therefore, recognized maritime pictures and the relevant data and communication exchanges are high value targets for cyber hackers. Navies, coast guards, and law enforcement agencies involved in the maritime domain are thus well advised to conduct cyber vulnerability analyses. They should assess whether certain types of naval operations increase dependence on reliable real-time digital traffic, since adversaries might have a special interest in interrupting these operations. The analyses should also incorporate the private sector. Digitized global supply chains require data integrity to guarantee smooth operations and to make sure that transported goods are neither lost nor stolen. As a consequence, it might be useful to assess whether existing maritime safety and security regulations, such as the ISPS Code and other documents, already address cyber risks and if there is a need to adapt them in light of current and projected cyber vulnerabilities.

- **Promote human terrain mapping in the maritime domain**
  Growing maritime activities by non-state actors and the prospect of closer bonds between organized crime, pirates, and terrorist groups pose additional challenges for maritime surveillance. These challenges are similar to the situation that land forces face ashore: To operate effectively, there is a need for human terrain mapping to identify the key actors and establish social relations between them. Doing the same for the maritime domain might require new thinking, for existing recognized maritime pictures focus on identifying and tracking vessels. This, however, is no longer enough. To deal with cluttered maritime environments that provide manifold opportunities for non-state actors to conceal their activities, human terrain mapping will close an existing gap in maritime surveillance. In addition, human terrain mapping will also help establish connections between offshore and onshore activities by identifying the key actors involved on both sides. As a result, human terrain mapping can improve the sustainability of naval stability and naval law enforcement activities in concert with other operations planned and executed ashore.

- **Improve capabilities for non-cooperative identification of objects and Individuals**
  Identifying a target that is non-cooperative is a traditional challenge also in the maritime domain. Different technologies are available to identify non-cooperative platforms and reduce the population of the 'black picture.'[43] In contrast, the identification of individuals at sea is a more recent requirement that goes hand in hand with human terrain mapping in the maritime domain. The need to identify individuals is a direct consequence of asymmetric conflicts where non-state actors have the upper hand as they can conceal themselves more easily. But naval law enforcement operations create a need for the proper identification of individuals. As a result, navies have started to use biometrics like fingerprint identification, face recognition, or iris recognition to establish the identity of individuals. Biometrically enabled information is shared with partners to check criminal track records, for example. Non-cooperative identification of individuals by use of biometrics is more challenging. There are different biometric standoff technologies, but most of them work in controlled environments only. Using the same techniques in a maritime environment requires more research, which opens the door for international cooperation.

[43] *Maritime Surveillance in Support of CSDP*, p. 27.

- **Promote the use of predictive analytics and behavioral models**
  Locating, tracking, and anticipating possible threats to the maritime domain are key capabilities of the navies.[44] In a maritime environment, where non-state actors are increasingly active, these capabilities need to be strengthened by promoting the use of behavioral models and predictive analytics. These methods can be used to identify suspicious activities by comparing current information with patterns recognized from analyzing past information. In combination with modeling and simulation, the insights can be used to advance the quality of information generated by recognized maritime pictures, thus providing added value to operators, planners, and decision-makers engaged in the maritime domain.

6 Conclusion

Multiple uses of the maritime domain will create new challenges for maritime surveillance in the future. Some of these challenges can be addressed with the help of technology. Other challenges will require new concepts and perhaps even new institutional frameworks. Finding common ground to address these challenges will be far from easy. Too many different forces are pulling in different and sometimes even opposite directions.

As this analysis has shown, there are a growing number of non-state actors with a serious interest in maritime disorder. Tackling their activities is difficult, as they have mastered the art of concealment and established links between illicit economic activities and the regular economy. In addition, more and more states realize that command of the littorals is a currency that can be used to leverage their own political ambitions. Another group of states goes even further and engages in establishing strategic maritime power projection and A2/AD capabilities.

Overall, it seems that actors that want to use the maritime domain for their very own ambitions are gaining the upper hand, whereas actors willing to defend the freedom of the seas and the freedom of navigation face a hard time closing their ranks. As a consequence, it is not at all clear who will shape the rules, norms, principles, and standards that guide future action in the maritime domain. In the end, this is probably the most serious strategic challenge to the maritime interests of the transatlantic community. Its members will have to realize that aspiring countries from other regions around the world will contest their way of "leadership by standardization." This can create opportunities for cooperation, but it will also produce risks that need to be handled to avoid escalation.

[44] *Maritime Surveillance in Support of CSDP,* p. 43.