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Fixing Southeast Asia's Remote-Sensing Blind Spots

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Few regions are as reliant on the marine environment for food security, economic growth, and national security as maritime Southeast Asia. The region's waters constitute some of the most biodiverse marine habitats on the planet. The South China Sea accounts for an estimated 12 percent of global fish catch and employs as many as half of the fishing vessels in the world.[1]

But this marine environment is teetering on the brink of environmental catastrophe. Fish stocks in the South China Sea have been depleted by between 70 and 95 percent, depending on species, and the story is much the same throughout the region.[2] Fishers must operate farther afield for longer to fill their holds, often racing each other to catch ever-depleting numbers of juvenile fish.

The growing competition for marine resources also worsens interstate friction, as fishers are forced to operate farther from shore, often in neighboring exclusive economic zones (EEZs), and without permission. Formerly lawful artisanal fishers have become today's illegal fishing fleets, and coastal communities on disputed waters such as the South China Sea have every incentive to continue to operate in contested areas, even in the face of danger from competing law-enforcement and paramilitary forces. Most violent incidents in the South China Sea emerge from fishing competition, not oil and gas or military activities. That tendency only will increase as the marine environment deteriorates and stocks continue to shrink. And on top of this increasingly violent competition for fish, Southeast Asia's waters are home to a resurgent threat of piracy and maritime crime; illicit trafficking in arms, drugs, and persons, including by terrorist organizations; and ever more capable vessels from the Chinese navy, coast guard, and other state agencies that increasingly transit, survey, and otherwise operate in neighboring states' waters in a manner not always consistent with international law.

Yet countries in this region, despite being so reliant on the marine ecosystem and so threatened by illegal activities at sea, are largely "sea blind." *Maritime domain awareness* (MDA)—the ability to detect, identify, and track vessels at sea—remains underdeveloped throughout Southeast Asia. Naval and law-enforcement agencies lack the quantity and quality of platforms needed to enforce laws even when they can detect illicit activity. Information sharing both within and among countries remains underdeveloped.

The United States has been working to fill capability gaps with material support and training through efforts such as the Indo-Pacific Maritime Security Initiative (originally the Southeast Asia Maritime Security Initiative) and the Southeast Asia Maritime Law Enforcement Initiative. Partners such as Japan and Australia also provide maritime-capacity-building assistance in Southeast Asia, but the needs remain overwhelming. Even the outside security assistance received often focuses on expensive surface and air platforms that cannot possibly close the gap—procuring and maintaining enough patrol vessels and aircraft to monitor the vast waters of Southeast Asia effectively is a budgetary impossibility for most regional states.

Most violent incidents in the South China Sea emerge from fishing competition, not oil and gas or military activities.

Luckily, the last decade has seen the rapid development of cheaper, commercially available remote-sensing technologies that hold the promise of revolutionizing MDA for developing coastal states. However, Southeast Asian governments remain largely unprepared to take advantage of those opportunities. Additionally, the United States and other security-assistance providers have been slow to adapt to this changing ecosystem; they continue to try to mold the navies and coast guards of developing coastal states in the images of their own services, despite knowing that such an effort is doomed to fail. But affordable MDA tools exist in ever-greater numbers in the private sector, and Washington needs to refocus on facilitating access to these technologies and teaching best practices if it wants to be part of the solution.

This article opens with an examination of the remote-sensing tools that are or soon will be widely available to coastal states and how each will contribute to a revolution in MDA capabilities. It then provides a brief assessment of how well each of five Southeast Asian states—Thailand, Indonesia, Malaysia, the Philippines, and Vietnam—are incorporating available remote-sensing tools, structuring government agencies to take advantage of them, and establishing necessary regulations for their use. The article concludes with a brief discussion of MDA capacity–building efforts in the region by the United States and other states, and how they could focus more efficiently on boosting remote-sensing use by partner nations.

THE NEAR FUTURE OF REMOTE SENSING

It is 2025, and a notification pops up on a screen in the National Coast Watch Center in the Philippines. It provides a snapshot of data on a suspicious vessel detected in the Philippine EEZ. Early that morning, a commercial satellite in low-earth orbit had detected several very-high-frequency (VHF) radio emissions in the area—which was suspicious, since there were no fishing or other vessels broadcasting identifying information from that location. An hour later, another satellite had collected synthetic aperture radar (SAR) data over the area, which showed at least two metal-hulled vessels. A third "bird," this time collecting electro-optical imagery, had passed over a few hours later and the data had just come in. This triggered the notification.

The watch officer on duty checks the results. The SAR and optical imagery confirm the presence of two large metal vessels, which appear to be refrigerated cargo ships called reefers. The latter sensor also shows at least half a dozen wooden fishing boats nearby. The system has flagged the incident as probable transshipment of catch, which is what the officer expected; satellite detections of light sources in the area that month had shown an uptick in night fishing. The fishing boats likely are transferring squid and other high-value species bound for foreign markets.

Following protocol, the officer transmits a message to the closest Philippine Coast Guard station. There are no patrol ships close enough to conduct an interdiction at sea, but the service will have a drone overhead in under an hour. It will collect identifying information on the vessels to feed into a database accessible by law-enforcement officials in any country that is party to the Agreement on Port State Measures (known as PSMA)—which means almost everyone. The reefers likely will be impounded as soon as they try to off-load their catch. The smaller boats will get away, but their illicit network will take a hit, and the coast guard will step up patrols in the area.

This scenario is not speculative fiction; it is an example of the cost-effective MDA tools that will be available to all countries in the coming years. The shrinking costs of satellite construction and launch are creating a boom in commercial low-earth operations. This means that many remote-sensing technologies—such as high-resolution satellite imagery and SAR, which previously were available only to well-heeled defense and intelligence agencies—are entering the commercial market. Other technologies are emerging for the first time, made possible by experimentation in the marketplace, fueled by the much lower entry barriers to space. For island nations and developing states, this will be a game changer, assuming that they seize the opportunities it presents. It also assumes that the partners on whom they rely for capacity-building support, especially the United States, will help facilitate access to these technologies.

A nonexhaustive listing and discussion follow of the various remote-sensing technologies that are or soon will be at the core of smart MDA efforts, along with some of the major players bringing them to market.

Coastal Radar

Coastal radar has been the most important tool for vessel detection for decades and will remain an essential part of any MDA sensing network. But there is wide variation in the types and ranges of coastal radar.

For those that can afford it, high-frequency surface-wave radar can detect vessels effectively over two hundred nautical miles from shore. But the kind of affordable, generalized radar network that a developing coastal state would seek to operate generally covers only territorial waters and the contiguous zone, not the EEZ.[3]

Automatic Identification System

Automatic Identification System (AIS) transponders are mandated by the International Maritime Organization (IMO) for all vessels over three hundred tons that transit international waters.[4] These transponders broadcast identifying information about ships, including their IMO and Maritime Mobile Service Identity numbers, as well as, to prevent collisions, their heading and speed. IMO-approved class A transponders are designed to communicate ship to ship and ship to shore within a limited range. A global network of shore-based receivers exists primarily to monitor traffic in congested areas, such as ports and busy straits. The first satellite AIS receivers were launched between 2007 and 2010; this allowed detection of vessels with sufficiently strong transponders far from shore for the first time.[5]

AIS is invaluable for monitoring legal activity but has obvious weaknesses. It is up to the ship's captain to input the vessel's data and ensure the transponder is broadcasting, which allows criminals easily to disable or spoof their transmissions. Military and law-enforcement vessels are free to disable their transmissions at will. Any ship that is smaller than three hundred tons or only operates domestically is not required by the IMO to have a transponder. This includes most fishing vessels. Many states do require fishing boats to have AIS, but often only a cheaper class B transponder, which has an even more limited range, which often means that satellites cannot detect them.

Since the first AIS satellite launch, a commercial market has developed, driven largely by shipping, oil and gas, and other maritime industries that want to keep eyes on their vessels at all times. This market is led by companies such as ORBCOMM, exactEarth, and Spire, which supply AIS data to most of the publicly available vessel-monitoring platforms, including MarineTraffic, Windward, and Global Fishing Watch. Some of these platforms, such as MarineTraffic, combine space-based AIS with a network of shore-based receivers for a more complete picture.[6]

Most government agencies rely on noncommercial platforms to combine commercial AIS with other proprietary sensor data. The most widely used is SeaVision, developed by the U.S. Department of Transportation with support from the U.S. Navy and shared widely among American partners and allies. SeaVision combines unclassified data streams that include terrestrial and satellite-based AIS, a limited amount of SAR, and coastal-radar data shared by the participating countries. Dozens of partner nations are using SeaVision, including most of Southeast Asia.

Vessel Monitoring Systems

Vessel monitoring system (VMS) is a generic term for systems mandated at a national or subnational level to monitor commercial fishing vessels. VMS transponders are intended to fill the gap left by AIS. Ideally, all legal fishers operating in a coastal state's EEZ would be required to carry them on board to transmit the vessel's location and identifying information back to authorities in real time. Many commercial manufacturers offer VMSs with a wide range of capabilities and costs, but the purpose of all these systems is the same: to provide data that, combined with information from AIS, can ensure that *all* commercial vessels operating legally in a coastal state's waters can be monitored in real time. VMS, therefore, is a necessary component in any effective MDA network; without it, separating licit from illicit activity is all but impossible. This is because legal fishing vessels, which make up the largest number of boats in an EEZ at any time, cannot be otherwise distinguished from nefarious actors, since both are running "dark."

Electro-optical Imagery

Electro-optical collection systems detect reflected light, including bands beyond the visible spectrum, producing panchromatic and multispectral images. This is what most users think of when they discuss satellite imagery. Over the last fifteen years or so, falling prices for satellite construction and launch have driven down the cost of imagery collection, such that a commercial market has developed for the first time. There are two broad categories of imagery providers, both of which have a role in MDA.

The first group includes suppliers, such as Airbus, Maxar, and ImageSat, which have relatively small constellations of large, expensive satellites with long lifetimes. They provide the highest-resolution imagery on the market—in some cases down to thirty centimeters, which is the legal limit in the United States.[7] They tend to be reliant on large government contracts but increasingly augment these with commercial operations.[8] Their imagery can provide a high degree of detail about a vessel, making them particularly helpful in the identification part of MDA. But their relatively small constellations also make their imagery expensive and available only infrequently.

The other group of satellite imagery providers is being pioneered by Planet Labs. It and those seeking to follow its model are younger than the legacy providers and rely on larger constellations of cheaper satellites with shorter lifetimes in low-earth orbit. Their maximum resolutions are generally lower, making identification of specific vessels, or even vessel types, difficult, but their larger constellations allow much more persistent coverage of an area at a lower cost. And as their satellites improve they are closing the resolution gap rapidly, suggesting that soon it will be possible to get both persistent coverage and very high resolution at low cost.

The proliferation of remote-sensing tools means that . . . in the next few years the volume of . . . data will increase many times over. . . . Will relevant authorities . . . be able to collect it, process it, and compare it with other sources to create a robust MDA network?

However, that will not fix the greatest limitation of electro-optical imagery for MDA: the weather. Satellites cannot take pictures through cloud cover, and in Southeast Asia that can mean long stretches of blindness owing to storms.

Synthetic Aperture Radar

Synthetic aperture radar is radar imagery collected by satellite. It helps mitigate the weather problem, being unaffected by cloud cover—a major advantage. But it provides other benefits as well. It is very useful for identifying metal vessels at sea and can be used to detect environmental hazards such as oil slicks. Vessels also are much easier to detect in a SAR image than in an electro-optical one, since they present as bright spots on a dark background.

But what SAR gains in detection it loses in identification; it does not provide enough detail to distinguish individual vessels, and often not even vessel types. It also makes it difficult to detect ships close to each other, such as during transshipment at sea, because they will appear as one large object. And, of course, it cannot be used to detect ships with very little metal structure—which includes most artisanal fishing boats in places such as the Philippines and Vietnam.

Despite its limitations, SAR increasingly is seen as a vital tool in MDA capabilities because of the ease of vessel detection it provides. It is experiencing the same drop in price as electro-optical imagery, although a few years behind. The market for SAR is dominated largely by legacy players such as Maxar's subsidiary MDA and an Airbus constellation that includes multiple European SAR satellites. Outside the market, major players in the space industry such as China, India, Japan, and the United States operate their own SAR satellites.

But some new companies are seeking to disrupt the market in the same way that Planet Labs and its ilk are doing for electro-optical imagery. The Finnish company ICEYE, the U.S.-based Capella Space and Umbra Lab, and Japan's Synspective all have announced plans for large constellations of low-earth-orbit satellites that could provide much cheaper, more-persistent coverage at resolutions higher than one meter. ICEYE launched the first such satellite in 2018 and followed that with more launches in 2019 and 2020. Capella and Synspective made their first launches in late 2020, while Umbra planned to begin launches soon.[9] Completion of those constellations will have an enormous impact on MDA capabilities around the globe.

Low-Light Imaging

Low-light imaging refers to the detection of light sources in the visible spectrum, originally developed for meteorological research but more recently applied to the MDA field. This is made possible by the visible infrared imaging radiometer suite (VIIRS) sensor developed by the U.S. National Oceanic and Atmospheric Administration (NOAA) and NASA and launched in 2011. The sensor's primary mission is to detect moonlight reflecting off clouds.[10] However, it also is capable of detecting the bright lights that many fishing vessels use to attract fish at night—an especially popular technique when fishing for squid and other species in the waters of Southeast Asia and the Pacific.

The Earth Observation Group at NOAA developed algorithms to identify fishing activity, plus a handful of other sources of light such as gas flaring, but not the modest light sources that commercial vessels in transit put out. NOAA released this VIIRS Boat Detection tool free to the public until late 2019 and the Navy began including its data in SeaVision.[11] Since then, the Earth Observation Group has moved from NOAA to the Colorado School of Mines, where it continues to release the VIIRS Boat Detection tool, charging nothing for data with a forty-five-day delay and a subscription fee for near-real-time data.[12]

VIIRS has obvious limitations. For instance, it can detect a dark vessel when correlated with AIS or VMS, but it cannot provide the details needed to identify it. It is unable to disaggregate light sources that are close together, so it cannot tell whether a return comes from one boat or a whole fleet. But it provides useful information about fishing patterns at large scale. Given the success of the VIIRS Boat Detection tool, other players likely will develop new low-light-imaging platforms for MDA.

Radio-Frequency Detection

The term *radio-frequency detection* refers to satellite-based sensors that can triangulate the location of terrestrial radio-frequency broadcasts, including from vessels at sea. This technology is a new entrant into the remote-sensing market, but it has great potential for use in MDA. Early innovators on this front are the U.S.-based HawkEye 360 and the French company Unseenlabs. HawkEye 360's growing constellation of satellites can detect a range of frequencies, including AIS, VHF channels 16 and 70 (used for distress signals and safety announcements), X-band radar, emergency locator beacons (known as EPIRBs), and L-band radio frequencies used for global positioning systems, including China's BeiDou.[13]

These transmissions can be used to detect otherwise dark vessels, because even ships that disable or do not carry AIS or VMS transceivers still use marine radar, radios, and other transmitting devices. It also can be used to detect intentional spoofing of AIS by determining that a vessel's broadcasts are not coming from where its transponder indicates it is located. A cluster of radio-frequency-detecting satellites, in a single pass, can triangulate the location of dark vessels over a very wide area. This makes it an efficient means of initial detection, which can trigger more-targeted remote-sensing tools to follow up and identify suspicious vessels.

Data Processing

The processing of data is just as important as data collection. The proliferation of remote-sensing tools means that private individuals and state actors both have access to a previously unimaginable amount of data about the maritime domain, and in the next few years the volume of those data will increase many times over. By the mid-2020s, it will be all but impossible for a vessel of more than a few meters in length to operate at sea without detection.

The question is, Will relevant authorities make use of that information effectively? Will they be able to collect it, process it, and compare it with other sources to create a robust MDA network? Part of the challenge will be bureaucratic; authorities must make sure that remote-sensing data are getting to the right agencies in an efficient manner, not lost in the interagency "food fights" endemic to all government bureaucracies. But an equal part of the solution will be technological, relying on artificial intelligence and machine learning to collate remote-sensing data so that suspicious vessel behavior can be flagged quickly enough for law-enforcement agencies, fisheries managers, and others to act on it.

Leading efforts on this front include the work of OceanMind, a nonprofit that began in 2014 as a partnership between Satellite Applications Catapult and the Pew Charitable Trusts before becoming an independent entity in 2018.[14] OceanMind develops tools to automate vessel detection from remote-sensing sources, provide real-time alerts about potential illicit activity, and more. Skylight, a branch of late Microsoft cofounder Paul Allen's Vulcan Inc., is engaged in similar efforts. Another promising company in this field is Orbital Insight, although its object-detection algorithms are not focused primarily on MDA. All three outfits concentrate to one degree or another on using artificial intelligence to automate the process of vessel detection in SAR or electro-optical imagery and the subsequent correlation of that information with AIS and VMS data.[15]

Global Fishing Watch, which was launched by Google, Oceana, and SkyTruth but is now an independent organization, takes a different approach. It publishes fishing vessel AIS data from around the world in real time and invites the public to help analyze and identify irregularities—in effect, crowdsourcing the fight against illegal fishing. It also has added VMS transmissions from willing partner nations, along with VIIRS data.[16] Israel-based Windward has developed its own AIS platform, along with numerous algorithms to automate the detection of unusual or illicit activity such as transshipments at sea and intentional spoofing or disabling of AIS.[17]

This is just a sampling of leading private-sector efforts to develop remote-sensing tools for MDA. Space-based tools and analytic platforms that previously were the sole domain of governments are being replicated by nonprofits and commercial technology firms, while entirely new technologies are emerging from the private sector. Radar and patrol platforms will continue to play critical roles, but the foundation of effective MDA has moved to space-based assets. Most coastal states, however, remain unaware of or too slow to adapt to these new technologies.

SOUTHEAST ASIA'S REMOTE-SENSING STRUGGLES

Given their long list of maritime-security challenges and considerable MDA gaps, Southeast Asian states are underutilizing remote sensing. Thailand has surged ahead of the rest of the region in recent years in experimenting with new technologies and partnering with the private sector, but it still has a lot of work to do. Indonesia made some important strides over the last five years, as countering illegal fishing became a major focus of the government, but it has yet to move much beyond legacy technologies, and interagency competition severely hampers effective use of the data it does receive. In Malaysia, the Philippines, and Vietnam, sea blindness is the rule, not the exception. All three have recognized the need to improve MDA and are making modest improvements, but none has an effective VMS or adequately incorporates surveillance tools beyond AIS, coastal radar, and surface or air patrols.

Only these five states are examined here. They share similar challenges: large and difficult-to-monitor EEZs, historical underinvestment in maritime capabilities, and constrained government budgets. Neighboring Singapore, by comparison, is the most technologically advanced state in the region when it comes to MDA capabilities, but with its small EEZ and developed economy it does not share many of its neighbors' constraints in this area, nor does it require significant maritime-capacity-building assistance from outside partners such as the United States.

Thailand

In April 2015, Thailand's seafood industry received a "yellow card" from the European Union (EU), owing to gross violations of international law. Bangkok was given a limited time to show improvements or it would suffer a ban on seafood exports to the European market. Since then, Thailand has worked to improve its

MDA and enforcement practices to comply with international standards, and the yellow card was lifted in early 2019.[18] The country signed on to the PSMA in 2016 as a sign of continued efforts toward combating illegal, unreported, and unregulated (IUU) fishing.[19]

Thailand explicitly requires VMS devices on all fishing vessels operating in its waters. It issued a royal ordinance to this effect in 2015 and immediately followed up with guidance from the Department of Fisheries on how VMS installation would be inspected and enforced.[20] Since then the government has issued regular amendments clarifying VMS compliance requirements.[21] Even with the EU yellow card lifted, Thailand continues to take VMS implementation seriously as a tool for IUU prevention and enforcement. The Department of Fisheries uses both VMS and AIS data to alert the Thai Maritime Enforcement Command Center (THAI-MECC) or law-enforcement agencies of any violations occurring in their jurisdictions. Like most Southeast Asian states, Thailand is a partner in SeaVision and uses it to access terrestrial and satellite AIS alongside its own data, including from coastal radars.

The Department of Fisheries has embarked on a landmark partnership with OceanMind and the Seafood Task Force, another international nonprofit, to improve monitoring and seafood traceability for its fishing fleet. Given OceanMind's competencies, this likely includes some analysis of SAR data.[22] SeaVision also provides access to some SAR data, though users have limited ability to order collections. This dabbling with SAR is an important step but the tool still does not seem to be a routine component of MDA operations by the Department of Fisheries or THAI-MECC. The same is true of electro-optical imagery and VIIRS. While Thai authorities might be using these for pilot projects, they are not used in day-to-day operations. Instead, Thailand remains primarily reliant on law-enforcement vessels and patrol aircraft, including unmanned aerial vehicles, to follow up on any suspicious activity that AIS or VMS detects.[23]

One of Thailand's most important steps to improve MDA and interagency coordination was the strengthening and reorganization of THAI-MECC in 2019. Previously the Thai Maritime Enforcement *Coordinating* Center, the renamed body has become a leading example for the region of how to empower a single government agency to combine information from relevant maritime departments into a common operating picture.[24] It is empowered to handle all national-level MDA, including for both law-enforcement agencies and the armed forces. The Royal Thai Navy, the Marine Department, and the Department of Fisheries all are required to feed AIS, VMS, and other forms of information to THAI-MECC, which collates it and shares information about violations with enforcement agencies. THAI-MECC is now Thailand's national single point of contact to coordinate with partner nations on maritime-security issues and is expected to develop into a robust maritime fusion center to collect, process, and distribute remote-sensing data.

Indonesia

Shortly after his election in 2014, Indonesia's president Joko "Jokowi" Widodo appointed businesswoman Susi Pudjiastuti as minister of maritime affairs and fisheries. For the next five years, Minister Susi led an effort to halt rampant IUU fishing and protect local fish stocks, and thereby to safeguard the archipelago's marine economy. In 2014, she convinced Jokowi to declare a one-year moratorium on all foreign fishing in Indonesian waters; later that year, she launched her trademark policy of sinking foreign vessels caught fishing illegally.[25]

Indonesia first mandated the use of VMS devices by "any person performing business and/or activities on fishery management" in 2009.[26] In 2015, Susi's office finally issued Regulation No. 42, which provided guidelines on VMS implementation. The regulation set up a fisheries-vessel-monitoring center and assigned a director general in the Ministry of Marine Affairs and Fisheries to standardize VMS operating procedures for all vessels and manage inspections and installation of transponders via a team of fisheries supervisors. This director general was tasked with handling all VMS data and conferring with counterparts across ministries to sanction violators. The regulation also set out stringent requirements for potential VMS vendors. All Indonesian fishing vessels over thirty tons now must have a VMS device installed, which they are required to keep on at all times while fishing, along with a certificate proving that the vessel's data can be transmitted successfully to the fisheries-vessel-monitoring center.[27] In June 2017, Indonesia became the first country in the world to share its national VMS data publicly, allowing the information to be published on Global Fishing Watch's online platform.[28]

By the mid-2020s, it will be all but impossible for a vessel of more than a few meters in length to operate at sea without detection.

Like many counterparts in Southeast Asia, Indonesian maritime agencies rely on SeaVision to gather AIS data and collate them with other tools, including coastal radar. Like their Thai counterparts, Indonesian law-enforcement and fisheries-management agencies are using electro-optical imagery, SAR, and VIIRS in small-scale research projects, but these technologies do not seem to be part of day-to-day MDA operations. Instead, Jakarta continues to rely on an insufficient number of air- and surface-patrol assets to augment the country's AIS and VMS capabilities. This means that Indonesian maritime agencies, which are less well funded, less capable, and less coordinated than those in Thailand, are stuck in a hopeless game of Whac-A-Mole. They disrupt a small percentage of the illicit activity in one of the world's largest EEZs, but most of the bad actors continue to operate undetected.

Interagency rivalry compounds these problems. The Indonesian Maritime Security Agency, or BAKAMLA, often is referred to as Indonesia's coast guard, but it does not have the resources or the sole mandate to fulfill such a charge. BAKAMLA was formed in December 2014 to coordinate law-enforcement capabilities across all agencies, as well as to conduct its own operations.[29] It technically has a mandate to collect all maritime intelligence and information from and disseminate these to other relevant law-enforcement bodies, which would include remote-sensing data. But it has no authority over counterparts such as the navy or the water police, which means that in practice it cannot demand information from them. The navy in particular has strong bureaucratic incentives to hoard information and create its own separate operating picture.[30] The situation grew more complicated in 2015 when Jokowi set up a presidential task force to combat illegal fishing, to coordinate efforts among ministries.[31] In practice, the task force did not function as it was meant to because of bureaucratic "stovepiping" and a mismatch in priorities with the other agencies, which are not as focused on illegal fishing. The task force was disbanded in 2019 and a new Indonesia Maritime Information Center was launched in July 2020 to strengthen interagency coordination. The center is promising but remains untested.

Further improvements in MDA will require better interagency coordination, which is unlikely unless BAKAMLA is given the funding and mandate to serve as a national maritime single point of contact like THAI-MECC. Steps are being taken to establish a maritime information fusion center within BAKAMLA, which would be a welcome advance, but such a center will succeed only if other agencies and the armed forces are compelled to share more data.[32]

Jakarta took another important step with the recent announcement that BAKAMLA would be placed in charge of overall maritime security in the "North Natuna Sea"—that area of the South China Sea that falls within Indonesia's EEZ.[33] But it remains to be seen how well that order will be implemented and how much authority BAKAMLA will exercise over other agencies in practice.

Malaysia

Malaysia faces the same maritime-security challenges as Indonesia and Thailand, including illegal fishing, trafficking, piracy, and external security threats, especially in the South China Sea. However, maritime security and MDA capabilities have not received nearly the same high-level attention from the Malaysian government. Interagency rivalry, especially between the Royal Malaysian Navy and the Malaysian Maritime Enforcement Agency (MMEA), prevents effective information sharing and muddies the waters when it comes to determining jurisdiction. It took high-level political intervention in Thailand and Indonesia to prioritize greater transparency and information sharing as necessary components for improved MDA; in the absence of such leadership, Malaysia's maritime-security agencies continue the bureaucratic default behavior of hoarding privileged information and seeing transparency more as a threat of embarrassment than as an opportunity to improve performance.

Malaysia's use of remote-sensing tools for MDA is modest and hampered by unclear legal requirements, a lack of regulatory follow-through, and unequal access to information for responsible agencies. The Fisheries Department is charged with VMS implementation, but the system covers only large vessels, both Malaysian and foreign, operating far from shore. The regulation and implementation of the system are less clear than in neighboring Indonesia and Thailand. The 2013 National Plan of Action to Prevent, Deter and Eliminate IUU Fishing specifies that every fishing vessel over seventy tons, as a requirement for renewing a fishing license, must carry a mobile transceiver unit that reports the ship's location to the Fisheries Department's VMS system.[34] That document claims that Malaysia has been using satellite-based VMS since 1999, but if so it was only on a small scale; the requirement for vessels over seventy tons to be covered by VMS did not begin until 2006.[35] Senior officials have indicated that implementation and enforcement were not strict until around 2014.[36] Regardless, the system covers only a small percentage of total fishing activity in Malaysian waters. The 2013 national plan claimed that VMS requirements would be expanded to other types of vessels, but that does not appear to be happening.[37]

The Royal Malaysian Navy and MMEA use AIS to monitor commercial traffic in the country's waters, but not in an efficient or collaborative manner. Both have access to shore-based AIS receivers.[38] But while the Royal Malaysian Navy uses SeaVision to integrate this information with satellite-based AIS and other data streams, it has no obligation or incentive to share these additional data with MMEA or other agencies. The navy devolves remote-sensing information gathering to local commands, which make an assessment before sending enforcement vessels to investigate suspicious activity. No Malaysian agency seems to be using other remote-sensing tools, whether electro-optical imagery, SAR, or VIIRS, as part of normal MDA operations, though they have access to limited amounts of each through SeaVision.

There is no maritime single point of contact or fusion center in Malaysia, save for one that the armed forces operate at Tawau, which only monitors security threats off the east coast of Sabah. MMEA is the obvious candidate to fill this role. It was established in 2004 and explicitly was empowered to carry out coastal surveillance and "enforce law and order under any federal law."[39] The agency has plans to establish its own fusion center, but bureaucratic hurdles prevent it from playing a robust interagency coordinating role. Its legal authority to mandate cooperation from other agencies is vague—purposefully. Meanwhile, Malaysia operates multiple competing interagency groups and ad hoc committees with authority over maritime surveillance, including the National Security Council, the Maritime Information Exchange Centre, and the Action Committee on Maritime Operation. The National Security Council has a National Surveillance and Operation Centre to coordinate intelligence and information sharing, but it is focused on traditional national-security threats, not MDA.

Philippines

The Philippines is likely the most sea blind of the countries examined in this article. It combines limited remote-sensing and patrol capabilities with a larger and more challenging maritime geography than most other states. Manila's inability to monitor its vast EEZ effectively has been on display for years, especially in contested areas of the South China Sea. But it also has difficulty keeping an eye on its archipelagic waters and territorial sea. That is why President Rodrigo Duterte recently demanded that all foreign vessels seek permission before transiting Philippine waters.[40] The order violates international law and Philippine authorities have no capability to enforce it. It also shows how sea blindness leads to bad policy making by robbing authorities of necessary information and casting the maritime commons as a source of unknown threat rather than shared opportunity. The silver lining for the Philippines is that it recognizes its own MDA shortcomings more than many of its neighbors, is undertaking some needed regulatory and bureaucratic fixes, and enjoys considerable outside capacity-building support—especially from the United States.

The Philippines is the only country examined in this article that has no VMS system in place. The Bureau of Fisheries and Aquatic Resources (BFAR) laid out plans for a nationwide VMS system covering licensed fishing vessels in the EEZ and high seas in 2012, but they were never implemented.[41] The bureau issued new regulations mandating VMS in 2018, but there has been little movement so far. The regulation called for all vessels over fifty tons to be equipped with VMS within one year—a deadline already missed—with those between thirty and fifty tons to follow within two years.[42] BFAR has stated that installing VMS on more than five thousand vessels is an important component of its Integrated Marine Environment Monitoring Phase II program, which seeks to create a fisheries-monitoring center in line with recommendations that different regional fisheries-management organizations have made.[43]

The Philippine Navy, BFAR, and component agencies of the National Coast Watch System make regular use of both terrestrial and satellite-based AIS through SeaVision.[44] However, SeaVision and other platforms are not used uniformly across all agencies. Beyond AIS, the Philippines does not seem to be using any remote-sensing technologies in normal MDA operations, although it could be experimenting with SAR and electro-optical satellite imagery. Philippine academics and nongovernmental organizations have begun using VIIRS to study fishing patterns, which might raise the technology's profile in official government circles.[45]

The Philippines established the National Coast Watch System in 2011, with support from the U.S. government. It is intended to be the primary interagency coordinating mechanism for maritime security and MDA. It consists of the National Coast Watch Council, established via executive order in 2012 to coordinate maritime policy, and the National Coast Watch Center, which serves as a maritime fusion center to collect and distribute data to relevant agencies. It is run predominantly by the Philippine Coast Guard but is supported by ten different agencies—with sometimes conflicting mandates and little desire to share data. These include the Philippine Navy, the national police, BFAR, and the drug-enforcement agency.[46] It also is unclear how the National Coast Watch Center, which is tasked with 24/7 monitoring of the maritime domain through the various components of the National Coast Watch System, will integrate—or compete—with BFAR's planned Fisheries and Marine Environment Center, with its fifteen regional monitoring centers across the Philippines. The former will not be able to establish an effective MDA system without access to the latter's VMS data.

Saving dwindling fish stocks, dismantling trafficking networks, preventing the spread of Islamic State–linked terror cells, countering Chinese aggression in the South China Sea—meeting these . . . challenges is impossible without much better ability to detect, identify, and track vessels at sea.

Vietnam

Since receiving a yellow card of its own from the EU in October 2017, Vietnam has taken a raft of steps to crack down on its fishers' illegal activities and to monitor its waters better. Part of this effort has involved some uneven implementation of new remote-sensing plans, mostly at the provincial level. While Hanoi has made considerable progress on the regulatory front, actual MDA capabilities remain lacking. Following the issuance of the yellow card, Vietnam passed a new law on fisheries in November 2017 and in 2018 released a national plan of action to deter illegal fishing.[47] Hanoi formed the National Steering Committee on IUU Fishing Prevention in May 2019 to coordinate its efforts better—likely with an eye toward the European Union's review of its progress in November. That committee reports directly to the prime minister.[48] The Europeans decided not to lift the yellow card at that time but praised the steps Hanoi had taken.[49]

Vietnam's 2017 law on fisheries mandates that all commercial fishing vessels over fifteen meters be equipped with VMS. At the time of the law's passage, only three thousand Vietnamese fishing boats had such systems, under a program called MOVIMAR. That effort was funded by France's development agency and makes use of French space agency satellites, primarily to track ocean conditions and issue storm warnings to the vessels, not to monitor their fishing activity.[50] The 2018 national plan of action called on the Directorate of Fisheries and individual provincial governments to make better use of MOVIMAR to detect and deter illegal fishing. As a result, plans are under way to install the systems on all fishing vessels, starting with those at least twenty-four meters in length, then expanding to all those of at least fifteen meters. But the Ministry of Agriculture and Rural Development, which oversees the Directorate of Fisheries and wrote the plan of action, is leaving implementation to provincial authorities, resulting in uneven progress. The EU cited slow installation of VMS transceivers as a reason for not lifting the yellow card.[51]

Aside from VMS, Vietnam's remote-sensing capabilities are extremely underdeveloped. The Vietnamese navy, coast guard, and Fisheries Surveillance (a branch of the Fisheries Directorate) are the primary actors in the maritime-security and MDA space. But there is no evidence that any of them make regular use of remote-sensing technologies, aside from coastal radar and terrestrial AIS. Vietnam has a robust network of shore-based AIS stations and recently was added as a SeaVision participating country. But it shares only a fraction of its terrestrial data and does not appear to use the platform in day-to-day MDA operations. It seems likely that a small number of Vietnamese users are testing out the platform, so relevant agencies could adopt it more broadly in the future.[52]

The Vietnam National Space Center (VNSC), under the Academy of Science and Technology, is responsible for obtaining and sharing space-based remote-sensing data. But its focus is mostly on developing national space capabilities, not collecting and analyzing remote-sensing data from commercial and partner-nation sources. For instance, the center plans to launch Vietnam's first national SAR satellite in 2023.[53] But with hundreds of low-cost commercial SAR satellites going up in the next three years, this at best will duplicate, and in many ways fall short of, capabilities available on the commercial market. The VNSC also has no clear authority to request VMS data from the Directorate of Fisheries. Nonetheless, the center would constitute the most sensible choice for a future maritime fusion center—if it were given more power to coordinate among relevant agencies and if it refocused its mission on efficiently boosting MDA capabilities using all available sources.

Vietnam also lacks a maritime single point of contact to coordinate efforts and work with partners. Each province operates its own regulatory bodies with only general guidance from national agencies, and there is limited coordination among relevant national-level actors. The Ministry of Agriculture and Rural Development is responsible for combating IUU fishing through the Vietnam Fisheries Resources Surveillance; the Ministry of Foreign Affairs' National

Border Commission is the principal agency for the National Steering Committee on the East Sea and Islands; and the Ministry of National Defense oversees the navy and coast guard and maintains its own operating picture at sea. None of these has clear authority to coordinate information sharing in the name of greater national MDA.

There is no greater security need in Southeast Asia than improved MDA. Saving dwindling fish stocks, dismantling trafficking networks, preventing the spread of Islamic State–linked terror cells, countering Chinese aggression in the South China Sea—meeting these and many other challenges is impossible without much better ability to detect, identify, and track vessels at sea. Yet regional states historically have underinvested in patrol and sensing capabilities in both naval and law-enforcement agencies. They also have proved very resistant to information sharing, both within and among countries. This is changing slowly, in places such as the Sulu Sea and the Strait of Malacca, but much more work is needed.

Improving MDA in Southeast Asia also is critical to the national-security interests of the United States and other outside parties. The South China Sea is a primary theater of U.S.-China competition, and the inability of other claimants to monitor Beijing's activities effectively is one of the foremost challenges in these waters. Poor MDA makes Southeast Asia a continuing hot spot for trafficking, piracy and maritime crime, and transnational terrorism. And rapidly depleting fish stocks threaten the livelihoods of tens of thousands, the food security of millions, and potentially the stability of governments in this critical region.

The U.S. government and its partner governments recognize the challenge, as reflected in the unprecedented amount of security assistance directed at maritime capacity building in Southeast Asia. But Washington still is focused too much on high-end maritime-security cooperation at the expense of nuts-and-bolts MDA capabilities. It tends to focus on naval operations rather than law enforcement, because most engagements take place between the Pacific Fleet and partner navies. Even when law enforcement is the focus, the United States and like-minded security partners most often focus on replicating their own best practices in conducting MDA operations. The same goes for the sensing and patrol platforms that they transfer to regional states. But trying to implement twentieth-century MDA solutions that work for developed states is not going to be cost-effective for developing coastal nations in the twenty-first century. Coast guard cutters and manned patrol aircraft are important, but they also are expensive to obtain, operate, and maintain, which means that Southeast Asian partners never will have enough to monitor their vast waters effectively.

Luckily, MDA in the coming decades will be dominated by cheaper, more-efficient remote-sensing tools. The United States, Australia, Japan, and others should not abandon high-end maritime-security assistance, but they should shift more of their efforts toward introducing partners to the booming market in remote sensing. This will require recognizing that the days of relying on government agencies—or large government contractors—to develop and deploy most MDA technologies are ending quickly. The U.S. government should not try to re-create the remote-sensing technologies and platforms emerging in the private sectors just so it can provide its own version to partner nations; instead it should help introduce partners to the diverse offerings of the market. It should provide more assistance in processing the vast quantities of data that result. And it should advise partners on regulatory and bureaucratic best practices to use those data effectively in naval and law-enforcement operations. The future of MDA is increasingly clear; the United States and its partners in Southeast Asia should embrace it.

NOTES

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