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Techno-optimism and ocean governance: New trends in maritime monitoring

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A B S T R A C T

Monitoring marine activities has always been a difficult task due to the vastness of the world's oceans. This inability to properly monitor both high seas and territorial zones alike has meant that illegal activities at sea have been able to flourish, from illegal fishing to human rights violations to maritime piracy. Lately, however, the rise of new methods of technological monitoring – from satellites to UAVs – has increased optimism that a better, technologically-aided method of ocean monitoring and governance may help to diminish the proliferation of these and other illegal activities. This paper considers the ways in which technological innovation has been proposed to help ocean monitoring and governance, and analyzes the extent to which the optimism over these new techniques is warranted.

1. Introduction

Ocean governance has always been difficult due to the sheer size of the world's oceans. Covering 70% of the earth's surface, much of the ocean has historically been relatively inaccessible for land-based monitoring. Yet as new technologies have been invented, more of the world's ocean waters have opened for use by people, and thus the need for governance has likewise expanded. But state governance has always lagged behind the ability of people to access (and commit crimes) on the ocean, despite efforts made from shore to correct for these problems.

Why is ocean governance so important for states? In the past, much of the concern about maintaining free and safe waterways came from the importance of water-borne trade. This issue remains paramount today, of course, with over 90% of trade by volume being carried over water. But added to these issues of free trade and safe passage have been issues of resource scarcity within the last century, and these drivers have encourage states in claiming ocean waters and their underlying seabed for exclusive state use, and in protecting said resources from other states or non-state actors who may be interested in them as well.

This resource scarcity issue was one of the primary drivers behind the creation of the United Nations Convention on the Law of the Sea (UNCLOS) in 1982, which replaced the traditional "freedom of the seas" doctrine limiting states to a three mile territorial sea without further oceanic control. UNCLOS greatly expanded state reach over ocean waters, expanding the territorial sea out to 12 nautical miles and providing states with control out to 200 nautical miles over the living and nonliving resources of the water in the form of an Exclusive Economic Zone (EEZ). It also provided coastal states with control out to 200 nautical miles of continental shelf, with a possibility of extension to 350 nautical miles if approved by the Commission on the Limits of the Continental Shelf (CLCS).

UNCLOS massively increased the amount of control coastal states had over their waters and continental shelf, but in so doing, it became state responsibility to govern and protect these areas. Granting control over fisheries out to 200 nautical miles is a potential boon for coastal states, but only if they can protect these resources from poaching by rogue actors or by other states. Likewise, coastal states now also had to figure out how to regulate and control the growing offshore oil and gas industry, operating in waters further and further from land. This was certainly a huge opportunity for coastal states, to now have control over these important marine resources, but UNCLOS didn't necessarily provide coastal states with the tools to protect and regulate the resources of which they were now legal caretakers.

This paper considers the rise of governance issues over ocean resources, and explores some recent ways in which coastal states and individuals have looked towards increasing technology as an attempt to mitigate the difficulties of ocean governance. These include the use of drones, satellite technologies, and other unmanned systems to provide a degree of oversight over the world's vast ocean spaces. Many are optimistic about the potential for technology to prevent crimes at sea or marine resource theft, given that unmanned technological systems are cheaper and more accessible for states than traditional maritime coverage in manned ships. However, while these technologies may allow for monitoring, they don't solve the problem of enforcement, making it difficult to estimate their impact on resource theft and other maritime crime.

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2. Ocean governance

Much interest in ocean governance originates from the need to control crime at sea. Ormerod [12] cites the three crimes Greek city-states faced at sea: piracy, privateering, and reprisal. Piracy in the ancient Greek context referred to robbery at sea for private ends, privateering for acts of robbery at sea committed during wartime (though without the letter of marque that would become essential for later privateers), and reprisal as legally sanctioned crimes at sea that were allowed in response to an act done by another city-state or even individual [12].

The ancient Greeks found, as later civilizations would also, that the benefits that some individuals or communities gained from these crimes at sea would come to be overshadowed by their costs. While piracy, privateering, and reprisal allowed for a city-state to reap the bounties taken by ships that were not part of an expensive navy, they also led to difficulties for seaborne trade and resulted in citizens being harassed by ships belonging to citizens of other city-states. Since sea trade and travel were even more essential in ancient times due to the difficulty of travel by land, there would soon arise a greater interest in maintaining peace at sea.

Yet peace at sea did not necessarily correlate with governance. The ancient Rhodians, credited with the development of the first Western maritime law, sought only to prevent piracy and violence in the waters around the island of Rhodes, and not to exercise control over said waters [14]. This distinction was carried throughout ancient Greek maritime law, and would be incorporated into later Roman maritime law. The Romans, who viewed the Mediterranean proprietarily as "*mare nostrum*," or "our lake," still did not assert effective control over those waters – even when Rome was more than powerful enough to do so should it have chosen to [4]. Instead, Rome contented itself with ensuring no rival power had access to the Mediterranean, through the destruction of Carthage, and destroying pirate networks in the eastern Mediterranean.

The movement of the center of power from Rome to Constantinople, combined with the rise of Islamic power in the 600 s CE led to a clash of cultures regarding maritime law. The Byzantine empire, heir to Rome, continued to use the same approach that the Roman Empire always had – that the seas were open to all and controlled by no one. This was codified in the great Byzantine legal document, the Code of Justinian, and expressly based on earlier Greek and Roman law [4,14]. But the rise of a rival power in the form of Islam would lead to changes in the Mediterranean; by the 1000s, the Mediterranean was an Islamic, not Roman, lake – and subject to new laws.

Islamic maritime law introduced the idea of maritime governance zones. Given the struggles that various Islamic states had with European Christian rivals, the idea of allowing completely free reign over something as vitally important as ocean waters was tempered with the need to control and protect coastal spaces from naval enemies. Thus, Islamic authorities claimed the right of governance over the immediately adjacent waters to their land, defined by the distance that a ship's mast could be seen from land [8]. This governance was managed with a coast guard and coastal watch system, to ensure compliance and safety for the state.

These two concepts would eventually be combined into what was generally known as the "freedom of the seas" doctrine. Most famously articulated by Hugo Grotius in his work *Mare Liberum* (1609), the freedom of the seas doctrine called for free use of ocean waters by all, in part because the use of the ocean by one ship or one state did not interfere with its use by another. This was paired with the idea of a three nautical mile territorial sea, meant to act as a coastal defense zone for states and was often defined as the distance that a cannon could shoot. This system would remain in place for nearly 300 years.

But by the mid 20th century, Grotius's words were tested by growing resource scarcity in the world's oceans. The development of new technologies – better ships that could travel farther, refrigeration systems that kept fish fresh while far from port, and the growing successes of drilling offshore for petroleum – were challenging the logic that use of the seas could be limitless by all. States began to push the limits of their traditional three nautical mile boundaries. Some claimed exclusive jurisdiction over their fisheries, such as Iceland or Peru. Others sought to safeguard the mineral resources of their continental shelf, like the United States. Whatever the particular cause, many states of the era were interested in better safeguards over resources they had come to claim, however accurately, as theirs. The debates and occasional acts of violence would finally result in the codification of UNCLOS in 1982, providing states with a 12 nautical mile territorial sea, an Exclusive Economic Zone out to 200 nautical miles to control living and nonliving marine resources, and a 200 nautical mile continental shelf that could potentially be expanded out to 350 nautical miles with approval.

With all this new space, however, would come challenges. Many states now had control over waters that rivaled or overshadowed their territory in terms of sheer area. The right of ownership came with the responsibility of governance, and not all states were equally well positioned to manage these vast areas of salt water.

3. The saving power of technology

The inadequacy of many coastal states to fulfill their obligation to govern their waters became apparent very quickly, and in two main ways. The first was in the new rise of maritime piracy, thought during the early part of the 20th century to be a crime lost to history. The second was in the hard to track world of illegal, unreported, and unregulated (IUU) fishing. Coastal states with large amounts of ocean to control and govern now faced the challenge of keeping up with a mobile fleet of criminals at sea.

The case study in point for piracy is Somalia. With the fall of dictator Mohammad Siad Barre in 1991, the Somali navy essentially disappeared, leaving their oceans open to exploitation by ships from other states. When the Somali civil war collapsed into coalitions of warlords, the territory of Somalia was also effectively ungoverned. This combination of events allowed the rise of a new pirate industry in Somalia, where ships were targeted offshore and brought back to the Somali coast to be ransomed by their owners. The official government of Somalia, in exile and lacking any control within their territory, were powerless to stop the continued predation of the pirates. Yet according to UNCLOS, the 12 nautical miles of Somalia's territorial sea was effectively the same as land, and thus no other state had the legal authority to pursue the pirate problem. This led to the awkward situation wherein once every year, a representative of the government of Somalia would appear before the United Nations Security Council and formally give permission for other states to enter their waters and ask for assistance in order to help fight the pirates.

Piracy is less of a problem in Somalia today, due to two reasons. The first and probably the most important is that the Somali government has since regained power within the state's borders, and the various warlords who were sponsoring pirate activities have no longer been able to do so. The second reason is that, given Somalia's proximity to the high priority shipping lanes of the Persian Gulf and Red Sea, many states took it upon themselves to fight piracy in the region since they had the legal permission to do so. This was a highly expensive endeavor, however – in 2016, it is estimated that the world's navies spent over $228 million in counter-piracy efforts in the waters around Somalia [11]. This high cost comes despite the fact that there hasn't been a major hijacking by Somali pirates since 2012; maintenance of the peace continues to be expensive.

These are traditional methods of fighting piracy: increasing presence on dangerous coasts and increasing patrols at sea. The technologies used on board ships may have changed, but the methodology would have been recognized by Gnaeus Pompeius Magnus when he was dispatched by the Roman Senate in 67 CE to fight the pirates of the

Mediterranean. The problem with traditional methods is not their inadequacy, but instead their expense. In the case of Somalia, where pirates were capturing oil tankers and holding hostages for years at a time, the price was deemed worth paying. In other areas of the world, such as East Asia, the problem has been so pernicious that it continues despite attempts to prevent it [2].

The story of IUU fishing is much the same, and in fact, is related to the problem of crime at sea. IUU fishing, while generally a crime in itself, also lends itself to other crimes. For example, Somali pirates claim that they took to robbery because other ships illegally stole their fish; with no navy or coast guard to protect Somali waters, there may be elements of truth to this explanation (though it is unlikely to be the entire reason for the rise of pirate activity). Likewise, IUU fishing vessels may stay at sea for months or even years at a time, offloading their illegally caught cargo to other ships to land at port, and thus also can contribute to the problem of human rights violations up to and including forced labor and slavery at sea.

But finding a vessel catching fish illegally is difficult. Even coastal states with extensive coast guards and/or naval patrols find that locating a single ship at sea participating in illegal activities is nearly impossible. Moreover, given the high cost of patrols and the relative low reward in punishing bad actors, many states simply put forth the best effort possible and resign themselves to tolerating a certain amount of illegal activity. This is doubly the case for international waters, where certain types of fishing may be illegal but no state has the responsibility to do anything to protect marine life from these particular depredations.

This is where technological optimism has found its place. If manned patrols are too expensive and difficult, many have suggested the answer could lie in technological shortcuts. Of these unmanned solutions, satellites have garnered the most attention as a potential technological solution. Remuss [13] discusses the possibility of using satellites to help fight piracy, noting that satellites allow for the visual surveillance of a large area in a way that is compatible with international law. The relatively low cost of data acquisition makes the use of satellites appealing, and the data can be used for many valuable applications – determining the location of pirate bases or the size of pirate ships, for example [13]. However, Remuss warns that it should only be seen as a part of the larger world of counter-piracy efforts. It is impossible to sort through the vast collection of satellite data and images without some prior theory or knowledge of where to look for pirate havens or their ships, as the data collected is too much to all be processed manually. The more specific prior knowledge available, the less hours must be spent on manually going through the data.

Satellites have proven very valuable in the study of marine biology and oceanography. For biologists, tagging animals that can then be tracked by satellite allows a greater understanding of animal behavior with minimal disruption to the organism of interest. Likewise, oceanographers can use satellites to gather data from sensors dispersed in areas of interest around the world. But it is far more difficult to utilize satellite data without the use of a tracker or sensor pointing to an area of interest. This is not impossible; Fretwell et al. [5] demonstrated that southern right whales could be tracked visually from satellites, but application of this technique to ships would be difficult. The satellite imagery is not detailed enough for many distinctions to be made; Fretwell et al. [5] only knew their targets to be southern right whales because of the location and time of year, as distinguishing between species was not possible with their data. But this kind of differentiation would be vital for the application of this technology to ships, in order to single out those engaged in illegal activities. Determining whether a fishing vessel is engaged in legal or illegal techniques from a visual image alone is likely impossible for the foreseeable future, even as satellite technology improves.

AIS technology is also touted as of potential use for tracking crimes at sea. AIS, or automated identification system, technology is used to track ships at sea. Its original and primary purpose is for ships to be able to identify themselves and other marine traffic in order to avoid collisions, and is mandatory on ships of a certain size (or any ship which carries passengers). Because AIS data is designed to be transmitted from ship to ship and ship to shore, the data can be publicly captured and made available. Furthermore, because AIS serves a vital purpose for the ship in preventing collisions, it is difficult for a ship to simply turn off their AIS when engaging in an illegal activity. These dual qualities of public tracking and private purpose make AIS a potentially useful way for authorities to get a picture of where ships may be at sea – and thus what activities they may be conducting.

McCauley et al. [10] note that AIS data could be combined with geographic information about the world's marine protected areas (MPAs) to monitor whether illegal fishing is prevalent in these areas. There has been a rise in the creation of MPAs around the world in an effort to protect marine life, but many of these MPAs have been both massively large and highly remote, triggering questions of both their effectiveness and states' ability to monitor and protect these areas from illegal activity [7]. McCauley et al. [10] provide a case study considering Kiribati's Phoenix Island MPA, which covers an area of over 150,000 square miles. (For comparison's sake, Kiribati itself is only just over 300 square miles.) They find that by tracking AIS use in the Phoenix Island MPA, they can see a drop in fishing activity when the area was closed to fishing, and track vessels who are in the MPA to ensure that they are not engaging in illegal activity. AIS, the authors claim, is the first real way to monitor and protect these remote MPAs [10]: 1149).

There is a downside to AIS tracking technology though. While use of public tracking of AIS data may allow individuals to determine when criminal activity is taking place, as in the above example, it also allows those planning a crime at sea to gather intelligence. Pirates and armed robbers at sea can use AIS data to determine a ship's route and when it is traveling to and from a port. These security reasons are why the International Maritime Organization calls for care when making AIS data public, so as to not detrimentally impact the safety and security of ocean-going vessels International Maritime Organization [6]. AIS then is something of a double-edged sword when it comes to preventing crimes at sea.

These technologies have also been joined by those advocating for the use of unmanned aerial drones to undertake all sorts of marine monitoring – tracking everything from beach activities to whale populations. For example, drones that see through waves can see coral reefs and their fish populations, allowing for better monitoring of reef health and thus better policies to maintain it [3]. Much of the justification for using drones is the same as that of using satellites or other remote technologies – their large reach over vast areas combined with their low cost make them a cheap solution for the management of large marine spaces [1]: 52; [9]. However, Lukaczyk et al. [9] note as did Remuss before them, these drones must be used in a greater context in order to make the most of their data, and for the same reason – while drones can be used to collect vast amounts of data cheaply and easily, this data is unhelpful unless someone can use it to locate the activity of interest. Since manually going through the data is a time-consuming process, it is best to have some idea of where to look in order to narrow down this data to selections that are more likely to be of relevance.

4. Discussion

Technology thus allows for cheaper and greater monitoring of the high seas and coastal zones. But the ability to monitor is not in and of itself an answer to the problems of ocean governance. First of all, this monitoring must take place within a complicated network of existing legal treaties and regional governance bodies. UNCLOS, which delineates where coastal state control of marine waters ends, is the most prominent of these, but is far from the only international treaty concerning ocean activities.

There are several international conventions dealing with various

aspects of shipping. These regulate everything from what standards are necessary for a ship in order to safeguard the lives of those aboard to issues such as operational, accidental, and deliberate pollution at sea. Likewise, there are many governance organizations and treaties that deal with fishing. Some of these are general, such as the Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (2009). Others are specific to a geographic area, like the Commission for the Conservation of Antarctic Marine Living Resources (created in 1982), or to a specific species, like the International Commission for the Conservation of Atlantic Tunas (founded in 1972).

Before commencing monitoring activities then, a coastal state or organization must be understand this complicated community of regulators and treaties that currently exists, and decide which of the numerous proscribed activities at sea that they wish to monitor for. Illegal fishing, illegal dumping, human rights abuses, and piracy are a few such violations that may be of interest. Once this is decided and monitoring commences, there must be plans to analyze the data. This is potentially time consuming and very expensive since there must be some human analysis of the data, even if technology and preexisting intelligence allows for the elimination of all but the most likely areas of violation.

Once a violation has been discovered, then sanctioning must be undertaken. This is the most difficult part of the process, because at that point the violator must be located, taken into custody by the government of a coastal state or party to an agreement, and then prosecuted under that state's laws. But every state has different laws, and it is unclear that technological images or data are likely to be allowed as evidence in every court in the world's nearly 200 states. For example, AIS data could show that a ship was behaving suspiciously in a restricted zone, but would not provide solid evidence that those on board were conducting illegal activities. Moreover, given the difficulty of collecting physical evidence, many prosecution teams would be hesitant to take on the task of bringing someone to trial who committed their crimes potentially hundreds of miles out at sea. It is also very costly to collect evidence from far coastal zones or the high seas. Witnesses to illegal activities might be from around the world, given the global nature of the fishing and shipping industries, making these witnesses difficult or impossible to produce. This has been seen very prominently in marine piracy cases, but is likely to be true for any coastal or high seas violation. In the end, it may simply be easiest to use the same patrol ships and naval vessels to catch marine-based criminals in the act, and then issue citations or arrests on sight – the very thing that the technology was meant to reduce or replace.

Moreover, if convicted, punishment is also difficult. Collecting fines from ships and/or businesses not registered in the country of trial is unlikely to be an easy process. If the offense warrants jail time, this is an additional burden on the country that has already gone through the above expenses. The existing framework of international law lays this burden on each individual state, and most have found that the reward is simply not worth the effort.

5. Conclusion

The benefits of technology are clear. But is all this techno-optimism warranted? The difficulty with the potential use of technology to fill in the existing gaps in ocean governance comes not from the monitoring of these spaces but with issues of enforcement. These new technologies – drones, AIS, satellites, etc – are excellent at monitoring, as many including the authors cited above have pointed out. They allow a relatively inexpensive real time view of the ocean and various areas of interest, from potential pirate dens to the results of active coral reef management. But knowing what is happening in the oceans is not enough; there must be ways to ensure that illegal activities are not just known, but also prevented. And this is where techno-optimism is still overtaken by today's realities.

Enforcement is very expensive. To know that a ship is fishing illegally is not enough; to ensure that the activity does not take place, that ship must be tracked down and the violators prosecuted and punished. Drones or other remote technologies cannot enforce laws – the state is still responsible for maintaining enough of a coast guard to track down offenders and a justice system that can provided adequate punishment for deterrence. The expense and relative inability to monitor the world's oceans has indeed been a problem, but it palls in many cases compared to the inability and unwillingness of states to spend the time and effort needed to enforce marine laws.

The example of Somalia is likewise illustrative here. While a number of naval vessels from a variety of states were patrolling the waters off the Horn of Africa to deter piracy, few of these vessels wished to actually arrest any pirates. Should a pirate be arrested, he would have to be removed from Somali waters and transported to the flag state of the arresting ship, tried and sentenced in their justice system, and then could potentially begin a plea for asylum on a human rights basis. Because of this, naval ships went out of their way to avoid bringing pirates on board their ships at all, much less take up the expense and difficulty of arranging transport and trial at home. Massive amounts of money have been spent monitoring the waters of the Horn of Africa over the past decade – but the cost of enforcing international law against piracy through arrest and punishment is much, much greater.

New technologies, in conjunction with traditional methods, may be of use in fighting crime at sea. But they are far from a game changer. The difficulties of ocean governance remain what they ever were. Adequate marine governance is likely to always be expensive to enforce, even if the costs of monitoring decrease over time. The innovative use of new technology is an important step towards making our oceans safer, but that alone is not enough. A strong commitment to the cost of enforcement is likewise necessary if these technologies are truly to deter crimes at sea.

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