The Role of Radar in Supporting Marine Security Patrol

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***Abstract*—** The possibilities and advantages offered by Indonesian waters are considerable, and they can be leveraged as advantages to seize chances. Indonesian waterways are exposed to regular infractions and maritime crimes including illicit fishing because of the country's abundant marine resources and strategic location. Technology that can assist marine security patrol efforts is required to monitor violations that take place. Radar can be used to spot infractions early on and give warning. The radar's capacity to find targets and determine their location and distance allows for target identification. It's crucial to take into account the requirement for surveillance at sea level while choosing the type of radar. Additionally, it's important to pay attention to where the radar is placed.

***Keywords*—** Radar, maritime crimes, Marine Security Patrol.

I. INTRODUCTION

Indonesian marine waters have two-thirds of the entire jurisdiction of the Republic of Indonesia with an area of 5.8 million km2. Indonesia is in a strategic position by being the largest archipelagic country and the sea area it has which is very advantageous because it is located in the territory of Indonesia at a cross position between two continents and two oceans, namely the continents of Asia and Australia and then the Pacific and Indian Oceans. This makes Indonesia's sea waters become international shipping lanes. Indonesia's vast waters in which there are so abundant natural resources [1]. Abundant marine wealth has a lot of potential in it, for example, Indonesia is one of the largest fish producers in the world and the Banda Sea is the largest source of tuna [2]. The vast territorial waters of Indonesia provide many potentials and advantages and can be used as strengths in the form of opportunities that can be obtained.

The abundant potential of Indonesian waters can be an opportunity and on the other hand, it can be a threat. Threats will create obstacles and endanger the national interest. Threats that occur are generally in the form of illegal activities that violate Indonesian waters and endanger the territory of the Republic of Indonesia. The threats in question are an encroachment on territorial boundaries, armed robbery or piracy, accidents, state-organized crime, illegal fishing, attacks, and invasions. This threat needs further action, especially in transnational organized crimes such as smuggling of illegal goods and because of the very dangerous value of the threat. Illegal fishing must also be dealt with because these violations still often occur in Indonesian waters [3]. To overcome violations, technology is needed that can support maritime security patrol efforts. Radar can be used for early warning in detecting violations.

II. METHODOLOGY

A qualitative research methodology was used to perform this study. Literature review procedure to collect up-to-date information and references from a range of sources, which are then used as a reference for the study. We were applying literature analysis to the features of the Radar. Past research journals were reviewed to conduct the literature study, and an evaluation was then carried out. The findings and analysis were gathered by compiling a range of information from references to the findings of relevant journal reviews.

III. RESULTS AND DISCUSSION

Threats that endanger the sovereignty and integrity of the Unitary State of the Republic of Indonesia can be carried out in various ways and anywhere, be it by land, air, sea, cyberspace, or the internet, which are called cyber attacks. Threats can take the form of various forms, both activities that directly endanger and activities that do not directly endanger the safety of the nation and state. actual threats that occur at this time and potential that may occur in the future can come from within or outside the country and some use armed and unarmed force. Threats that occur now develop following the development of more advanced technology.

Threats from Indonesia's sea domain can take many different forms, including engaging in unlawful activities that break the law. Natural resource theft, international terrorism, and disputes over territorial boundaries are threats that have a high potential to materialize in Indonesian marine seas. These dangers may have an effect in the future, both short- and long-term [4]. It is crucial to take substantial measures to erect

a robust maritime defense because threats that arise at sea are quite concerning.

Threats in the form of theft of natural resources at sea are still common. Illegal fishing is a frequent occurrence in Indonesian waters because of the abundant fish population. Illegal fishing is generally carried out by ships from foreign countries. This illegal act often occurs in several areas including the North Natuna Sea, the Sulawesi Sea, and the Malacca Strait. Foreign vessels that frequently fish in the area include fishing vessels from the Philippines in the Sulawesi Sea, Malaysian-flagged fishing vessels in the Malacca Strait, and fishing vessels from Vietnam looking for fish in the North Natuna Sea. This can be validated by detecting Vietnamese fishing vessels located in the fisheries management area of the Republic of Indonesia using Automatic Identification System (AIS) data and then strengthened by detection using satellite imagery as shown in Figure 1. In Figure 1, fisheries supervisory patrol vessels from Vietnam, which are marked with a green dot with Kiem-Ngu's statement which is predicted to launch fishing activities in the region [5].

The rise of illegal fishing can occur within sea borders with close neighboring countries, and the enforcement of regulations and protection of marine areas has not been optimal [6]. As reported from Sindonews.com illegal fishing cases have been arrested by the Ministry of Maritime Affairs and Fisheries (KKP) in 2021 as many as 167 vessels. Violations in fishing are not in the form of illegal fishing, there are also catching fish that damage fishing as many as 96 perpetrators were arrested only in 2021. The activities of boats stealing fish are not a few using tools such as explosives and tiger trawlers. These tools can damage the sustainability of marine ecosystems because they can disrupt protected fish or animal populations and cause damage to coral reefs.

Fishing activities have a detrimental impact on the state. Illegal fishing causes considerable losses and can be worth Rp. 240 trillion per year, this loss was once explained by Susi Pudjiastuti who had served as Minister of Maritime Affairs and Fisheries of the Republic of Indonesia in the Working Cabinet for the 2014-2019 period [7]. Losses are also in the form of damage to marine ecosystems, both fish populations continue to decrease and damage to coral reefs. The losses experienced can be prevented by tightening the protection of marine areas and enforcing regulations to reduce the number of illegal fishing actions.

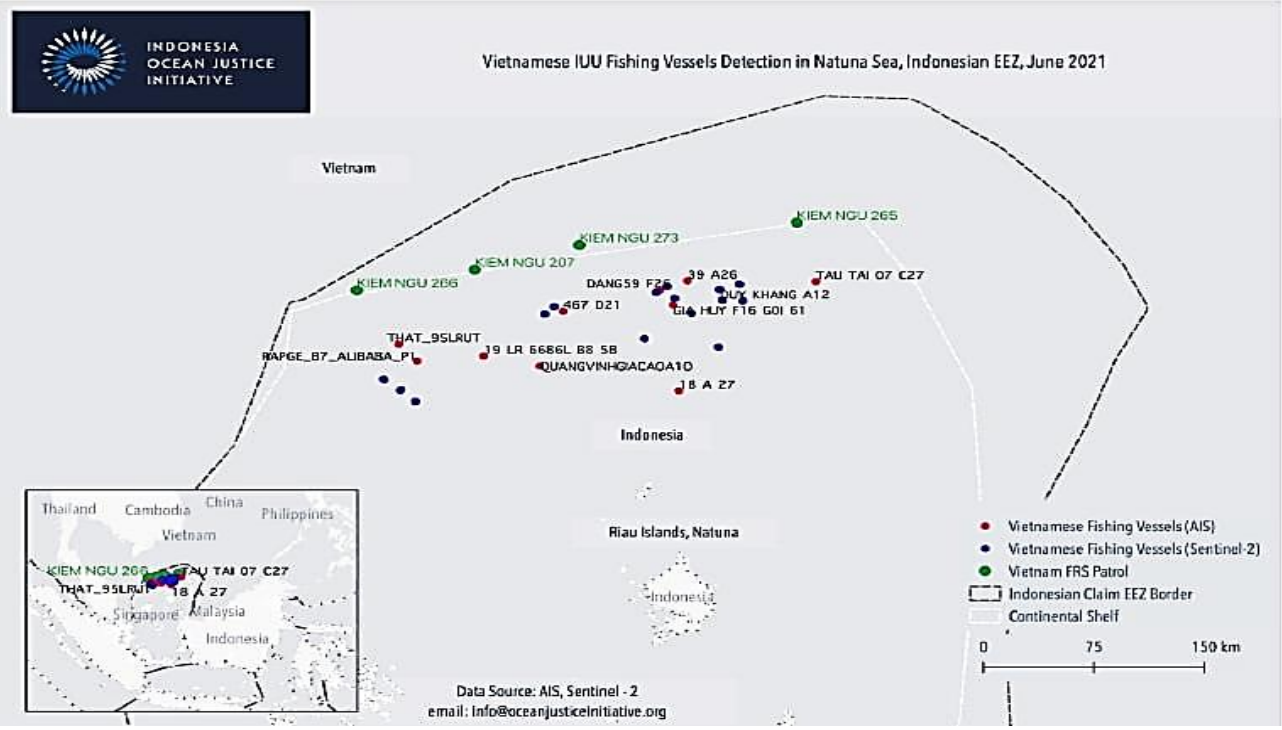

Figure 1: *Overlay of Vietnamese Fishing Vessels Detected by AIS and Satellite Imagery in June 2021[5].*

Indonesia is a big country with wide seas. Indonesia with 10 neighboring countries both land and sea. Indonesia's maritime boundary is a provision of the 1982 UNCLOS convention with the existence of Law Number 17 of 1985 concerning the Ratification of 1982 UNCLOS. In international regulations, the EEZ is 200 miles wide from the baseline so that the outer sea area is included in the country [8]. Being an archipelagic country is both an advantage and a challenge for Indonesia. The great natural resources of the sea such as fisheries and also the

abundant mineral content in the stomach are advantages that Indonesia has. Challenges or obstacles that are also experienced due to the experience of recognition from foreign countries at the border of national jurisdiction. The case triggered a conflict that could strain relations between countries. Territorial recognition issues in the Indonesian sea include the Timor Gap, Ambalat Sea, Sipadan and Ligita, and the North Natuna Sea which is known as the South China Sea [9]. Violations that often occur at the border such as the presence of foreign vessels fishing in any area in Indonesia and sea crossings without a permit. For example, Chinese state vessels carry out fishing activities in the North Natuna Sea. This is considered natural for China because the area is considered China's Nine-Dash Line and Traditional Fishing Zone [10].

The Indonesian Archipelago, with its vast marine area and located in a strategic position, makes Indonesian waters important for international shipping. The implementation of Indonesian Archipelagic Sea Lane (ALKI) is implemented to provide access to international shipping and flights. This ALKI makes national waters open for international transportation. The large water area makes monitoring less than optimal. This statement becomes the magnitude of the probability of a terrorist using this route to carry out his mission. Terrorism is unlawful activities that are generally related to politics, ideology, or religion which can be in the form of violence causing anxiety for the people or the government.

Indonesia's marine area holds great potential resources to become a national asset. This is the main attraction for parties to explore and utilize the resources in it. Various violations at sea can interfere with and endanger the interests of the state. Territorial sovereignty and national safety can be threatened due to violations of legal activities. Violations committed by parties without permission cause confusion with considerable value to the state. The best security patrols and strictly implemented rules are needed for maritime security, especially at sea borders.

Because of the size of the area owned, resource constraints, and the inability of patrol personnel to conduct continuous patrols, national waters supervision becomes challenging. Due to these restrictions, technology is required to facilitate maritime surveillance. Radar is a supporting technology that may be used. Radar, also known as radio selection and range, is a sophisticated system made up of transmitters and receivers, which are antennas used to transmit and receive signals. If there is an object, the signal is transmitted from the transmitter and is reflected by the object producing a return signal. The return signal must be amplified using a high-power amplifier because the receiver only receives it with weaker signal strength. The signal is then processed for easy user comprehension before being shown on the display unit [11]. A technology used to detect things as they approach the radar coverage area is called radar [12]. Target detection and target range estimation were the capabilities of the radar in its early stages of development. Radar has evolved into a sophisticated transducer system in the current period due to the rapid growth of technology. It can now track, identify, describe, and categorize objects to minimize undesirable interference like clutter and jamming [13]. Both military and commercial aircraft are tracked and detected using sophisticated radar, which is fitted on the aircraft to prevent collisions.

Radar technology that can be used in maritime is certainly different from air radar in general. Radar for maritime must have the ability to detect objects or targets on the surface. Radar used to monitor ships is usually called coastal radar or coastal surveillance radar. Radar of this type became diverse in its development. There are coastal radars that use Frequency Modulated Continuous Wave (FM-CW) which uses two separate antennas to receive and transmit signals, because the radar transmits signals it requires a separate antenna to receive signals. Limited range, Coastal radar on land cannot reach unreachable sea areas. Make the radar placed on land or shore and ships.

Another type of coastal surveillance radar is the IMSS (Integrated Maritime Surveillance System) surveillance radar. The IMSS surveillance radar uses frequencies in the X-band and S-band to allow detection of ships on the sea surface with a radar range of 96 Nautical Miles or about 177 kilometers. Radar can be used on land and ships because the radar range on the coast does not cover the existing sea level. This radar system is equipped with supporting equipment including AIS (Automatic Identification System) which is a transponder useful for identifying the identity of the ship. VHF radio is a means of communication with ships that are in and around it. This radio can be used to warn foreign ships passing by. There is also a long-range camera to take pictures of passing ships within a distance of 15 Nautical Miles that can be used during the day or night equipped with infrared [14].

The OTH or Over The Horizon Radar (OTHR) radar can also be used for air and sea surveillance. In general, radar technology in operation has limitations in a limited range. This limitation exists because of the curvature of the earth. As technology develops, these limitations can

be solved by using OTH radar. OTH radar has a very wide detection range of up to 3,000 kilometers with a frequency used between 2 MHz to 50 MHz [15]. This is because this type of radar mandates the ionosphere layer to reflect the emitted signal. The signal reflected into the ionosphere layer allows the OTHR to detect objects that are in the air or on the surface.

OTHR has been used by several countries to monitor their territory. Countries that have used this OTHR include Australia and the United States. Australia uses an OTHR known as Jindalee with the type of Over Horizon Backscattering using a frequency of 50 MHz which is capable of reaching up to 3,000 kilometers. OTHR owned by Australia is equipped with computer equipment to support the processing of the received signal. The OTHR used by the United States uses the Relocatable Over The Horizon type. This radar was developed to monitor the area of possession and control of drug trafficking, especially in the Caribbean Sea. The OTHR developed by the United States has a range of up to 3,700 kilometers [12].

The breadth of Indonesia's territory with a very wide sea makes surveillance with coastal radars with a much narrower range, so large quantities of coastal radar are needed to be able to monitor the entire territory of Indonesia. the use of OTH radar with a very wide area coverage, only a few radars are needed to cover the entire area. The advantages of this OTH radar can make it a solution to strengthen national defense and control the sovereignty of the Republic of Indonesia.

In using radar, the positioning of the radar needs to be considered. The precise location of the radar can optimize the performance of the radar in observation. The parameters for placing radar on the ground are generally the same as paying attention to the altitude of the location so that it is not obstructed by objects that make the radar unable to observe in the obstructed area. For coastal radar, it must also be at an altitude, coastal areas are dominated by lowlands with many obstacles, so use tall buildings to place the radar. Other parameters such as telecommunications infrastructure, roads, land cover, and disasters also need to be considered. For radars installed on ships, the placement of the ships can be in locations prone to violations.

In determining the location of the radar placement can use the GIS (Geographical Information System) method to make it easier. GIS is a system for making decisions related to geospatial data. In making decisions, the system requires input in the form of geospatial data which will then be processed and analyzed based on parameters to make decisions [16]. GIS can be used to determine a suitable location for placing radar so that the radar can work effectively in supporting maritime security patrols.

Application of radar in maritime for surveillance of ships that are in and through national waters. The ability of the radar to detect and identify objects within its scope can be an early warning if there are foreign ships that do not have permission to pass and enter the jurisdiction. It can support marine patrols in maritime security surveillance. limited ships for patrol can be used to capture and expel foreign ships without permission.

The radar on board the ship can be used for navigation and to maintain the safety of transportation. Radar as a potential navigation aid can determine the position and detect the presence of a collision. The impacts arising from marine accidents are in the form of human losses, namely crew and passengers, the environment, and finances for both the state and the company. Another impact is the disruption of shipping lanes or the closure of sea traffic lanes it hinders other shipping [17]. Radar can detect objects around it, if there are objects around the ship, an indicator will be displayed on the display unit and the ship can avoid it before a collision occurs. The use of radar is one form of efficiency in maritime security operations by reducing operational costs and increasing maritime security capabilities.

IV. CONCLUSION

The use of technology Radar to help with ocean-wide surveillance. The radar's capacity to find targets and determine their location and distance allows for target identification. Coastal surveillance radar and OTHR are two different forms of radar that can be employed. Due to the limited coverage area of coastal radar, it is also important to install onboard ships to monitor border seas. When performing observations, OTHR has a very large range of up to 3,000 kilometers. Because it is expensive to construct an OTHR, it is feasible to employ coastal radar, which is installed in densely populated areas and is subject to infractions.

To optimize the performance of radar observations the location to place the radar must pay attention to land suitability parameters. Methods that can be used to support radar location decision-making can use GIS. The use of radar in maritime security is very useful. Radar can be used for surveillance of national marine waters that operate every day.

Serves as ship navigation to prevent collisions. The use of radar greatly supports maritime security patrols by increasing guard capabilities and saving operational costs in patrols.

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