Use of Technology to Prevent Illegal Fishing: A Case Study Perspective in The Natuna Sea

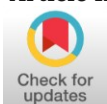## Geby Gita Srinita[1], Wan Jesica Febrianty[2]

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Abstract:
The use of technology in preventing illegal fishing (IUU) is critical in addressing the ongoing challenges in Indonesia's Natuna Sea, a region vulnerable to violations like illegal fishing, unauthorized vessels, and unlicensed resource exploration. The primary objective of this research is to explore the role of technology in enhancing the monitoring and enforcement of fishing regulations. Various technological tools, such as Vessel Monitoring Systems (VMS), Humanless Underwater Sensor Technology (HUST), remote sensing, and Automatic Identification Systems (AIS), are employed to improve surveillance capabilities. These technologies help track fishing vessels, detect suspicious activities, and gather evidence for legal enforcement. A qualitative descriptive research approach is used to analyze the effectiveness of these technologies and their integration into Indonesia's fisheries management system. Data is collected from secondary sources, including legal documents and research studies. The results show that VMS, AIS, and remote sensing have significantly improved the monitoring of fishing activities in the Natuna Sea. However, challenges such as limited data coverage, vulnerability to manipulation, and inter-agency coordination remain. The study concludes that while technology has proven effective in combating illegal fishing, further efforts are needed to enhance its implementation, including strengthening legal frameworks, political support, and inter-agency collaboration to ensure sustainable fisheries management in the region.

Keyword: Vessel Monitoring, Fishing Business, Protection, Development

INTRODUCTION

Indonesia is one of the largest archipelago countries in the world. Indonesia has very wide waters and a very wide sea area. In fact, Indonesia's maritime area exceeds Indonesia's total land area. The Special Economic Zone is a route outside Indonesia's territorial waters and borders. Simply put, the Special Economic Zone is Indonesia's third maritime boundary after the territorial boundary and continental shelf boundary (Frick et al., 2019; Moberg, 2015; Tang, 2023). SEZ was announced on March 21 1980 by Minister of Foreign Affairs Mokhtar Kusmartmadja. An Special economic zone, or SEZ, is a territorial boundary set 200 miles from maritime bases, and a country has rights to all natural resources within it. In addition, the state has the right to implement and enforce all legal measures and has the freedom to navigate and fly over its territory.

Indonesia's Special economic zone provides freedom of navigation and international air traffic, as well as freedom to lay undersea cables and pipes, in accordance with applicable principles of international maritime law. Natuna Regency, is one of the districts in the Riau Islands Province, Indonesia. Natuna is the northernmost archipelago in the Karimata Strait (Wang, 2013). To the north, Natuna borders Vietnam and Cambodia, to the south it borders South Sumatra and Jambi, to the west it borders Singapore, Malaysia, Riau and to the east it borders East Malaysia and West Kalimantan.

The use of SEZ in the Indonesian SEZ region is regulated in Law Number 5 of 1985 concerning Special Economic Zones. Articles 5 to 8 regulate exploration, exploitation and conservation of natural resources in the Indonesian SEZ region. Parties who wish to utilize natural resources in the Indonesian SEZ region must obtain permission from the Indonesian Government. However, most of these resources have not been maintained and have not been utilized optimally (Fauzi et al., 2022; Hidayat & Negara, 2020). This region is also prone to various violations, such as illegal fishing (IUU fishing), illegal shipping, and exploration of natural resources without permits. Law enforcement in the Natuna SEZ is important to maintain Indonesia's sovereignty, security and economic rights.

The most common IUUF activity in this area is illegal fishing. Illegal fishing will continue to occur in the Natuna Lake area until 2023. Based on AIS data received by the Indonesia Maritime Justice Initiative in February 2022, there are at least 12 Vietnamese fishing vessels and 8 Chinese fishing vessels suspected of carrying out illegal fishing activities in WPP 711 Natuna Sea North. The emergence of several cases shows the Indonesian government's commitment to safeguarding sovereignty and natural resources in the SEZ region, raising several questions regarding the effectiveness of the SEZ law in the Natuna Sea. One method that is very necessary for fisheries management is monitoring, control, and observation (Aggarwal, 2007; Farole & Akinci, 2011).

A fishing vessel monitoring system (vessel monitoring system) is a form of monitoring system in the field of catching or transporting fish, using satellites and transmitter equipment placed on fishing vessels to facilitate supervision and monitoring of fishing vessel activities based on the position of the vessel being monitored in the fishing vessel. screen vessel monitoring system at the fishing vessel monitoring center. In general, the status of various fish stocks and the marine environment has created strong incentives for countries to implement VMS as a component of an overall checking, control and reconnaissance strategy (Mahmood et al., 2019; Whitaker, 1987).

The emergence of innovative technology, especially those related to satellite-based VMS, has the potential to increase the effectiveness of checking, control, and observation systems through various useful information at relatively low costs compared to just relying on more traditional observing, control, and reconnaissance measures, such as enforcement law at sea manually. Vessel monitoring systems are used primarily for fisheries enforcement purposes, but also provide information on the spatial and global distribution of fishing activity for use in fisheries and environmental assessment and management.

This research is important as it addresses the growing concern over illegal, unreported, and unregulated (IUU) fishing activities in Indonesia's Special Economic Zone (SEZ), specifically in the Natuna Sea. IUU fishing not only threatens the sustainability of marine resources but also undermines Indonesia's sovereignty and economic rights. Despite the enforcement mechanisms already in place, such as satellite-based Vessel Monitoring Systems (VMS), IUU fishing activities persist in these regions, indicating a gap in the effectiveness of current regulations and monitoring systems. This study aims to assess the effectiveness of existing maritime laws and monitoring technologies in

combating illegal fishing in the SEZ, with a focus on Natuna, and proposes enhancements that could be made to improve law enforcement in these critical waters. Through this, the research will contribute to strengthening Indonesia's legal framework and monitoring systems, which are essential for preserving the country's marine resources and protecting its territorial integrity.

The problems this research seeks to address are multi-dimensional. First, there is an evident failure in fully utilizing Indonesia's vast maritime resources within the SEZ region, despite the legal framework established by Law Number 5 of 1985. Natural resources in this area remain underutilized, and in some cases, exploited illegally, jeopardizing both environmental sustainability and economic development. Second, the issue of IUU fishing in the Natuna Sea is a significant problem, with foreign vessels engaging in unauthorized fishing activities despite regulations meant to curb such practices. This illegal activity leads to severe depletion of fish stocks and threatens the livelihoods of local fishermen, undermining efforts to ensure food security and sustainable marine ecosystems. Moreover, the inadequacy of current monitoring, control, and observation systems, including the VMS, further exacerbates this problem, as it limits the government's ability to effectively detect and respond to illegal fishing activities.

Lastly, this study also highlights the lack of optimal enforcement of Indonesia's maritime laws within the SEZ, especially in remote regions like Natuna. While the law grants the government authority to explore and exploit natural resources, the capacity for enforcement remains weak, largely due to logistical challenges, limited manpower, and the vast expanse of the maritime zone. This results in a high incidence of illegal fishing and resource exploitation without the necessary permits, posing a severe challenge to Indonesia's maritime security and sovereignty. By investigating these issues and providing recommendations for improving the monitoring systems, law enforcement, and resource management strategies, this research aims to contribute to strengthening Indonesia's maritime governance and ensuring a more secure and sustainable marine environment.

RESEARCH METHOD

This research adopts a qualitative descriptive approach, focusing on the normative aspects of legal investigation (Miles et al., 2014). The primary objective is to explore and examine the laws and regulations applicable to the issue at hand, particularly in the context of Indonesia's Special Economic Zone (SEZ) and the Natuna Sea. The research aims to critically assess existing legal frameworks and their effectiveness in addressing issues such as illegal fishing and resource exploitation. In this study, the researcher plays a central role in data collection, actively engaging with secondary sources to gather relevant information. The qualitative nature of the investigation allows for an in-depth exploration of the legal structures, policies, and their application in the real-world scenario of maritime governance.

The data used in this research is secondary in nature, gathered primarily through library research, research documents, and data processing from external sources. Secondary data consists of various types of legal materials, including primary legal materials (such as statutes, regulations, and official documents), secondary legal materials (such as legal commentaries, academic articles, and expert opinions), and tertiary legal materials (such as encyclopedias, legal dictionaries, and other reference works) (Johnston, 2014). These sources provide valuable insights into the legal context surrounding the SEZ and illegal fishing issues. As a result, this research falls under the category of library research, utilizing available data from legal texts, media, and literature

to address the research questions and draw conclusions about the effectiveness of current maritime laws and enforcement mechanisms.

RESULT AND DICUSSION
1. Illegal Fishing: An Overview Conceptual
Illegal fishing, often referred to as unlawful fishing practices, encompasses a wide range of activities that violate established laws and regulations governing fishing in designated water areas. These practices include actions such as fishing without the proper permits, using prohibited fishing gear like trawls or explosives, operating in restricted zones or during prohibited seasons, and exceeding catch quotas. The act of illegal fishing undermines the regulatory frameworks set in place to protect fish populations and preserve the health of aquatic ecosystems, posing a significant threat to sustainable fishing practices.

One of the most immediate consequences of illegal fishing is its detrimental impact on the economy. By circumventing established regulations, illegal fishing leads to the depletion of fish stocks and diminishes the potential income that can be generated from legal and regulated fishing activities. Local fishermen, who rely on healthy and sustainable fish populations for their livelihoods, are especially vulnerable to the consequences of illegal fishing. As fish populations decline, their ability to maintain a consistent income is severely affected, further exacerbating the economic challenges faced by these communities.

In addition to the economic ramifications, illegal fishing poses a severe threat to the long-term sustainability of fisheries and marine ecosystems. Overfishing, which often results from illegal fishing practices, leads to a significant reduction in fish populations, disrupting the delicate balance of marine life. This disruption can have cascading effects on the entire ecosystem, including the loss of biodiversity and the destruction of critical marine habitats. Overfishing also weakens the resilience of ecosystems, making them more vulnerable to environmental changes and other human-induced threats.

Furthermore, the environmental consequences of illegal fishing extend beyond the direct harm to fish populations. The use of destructive fishing methods, such as explosives or banned trawling techniques, not only kills or captures fish indiscriminately but also damages the seafloor and other marine habitats. This can lead to long-term degradation of the marine environment, affecting not just the fish populations but also the broader ecosystem, including other species that rely on healthy habitats for survival. As a result, illegal fishing contributes to a cycle of ecological imbalance, posing a threat to the health of oceans and the livelihoods that depend on them.

2. Technology in Supervision Fishery
Technological advancements have significantly contributed to the improvement of fishery supervision, providing innovative solutions to combat illegal fishing practices. As illegal fishing continues to pose a threat to marine ecosystems and fisheries management, the application of technology has become essential for effective monitoring and control. These technological innovations have the potential to enhance surveillance, detect suspicious activities, and gather evidence of violations, all of which are vital for ensuring sustainable fisheries management and protecting marine resources.

One of the key technologies employed in fishery supervision is the Vessel Monitoring System (VMS), which enables authorities to track the location and movement of fishing vessels in real-time. This system uses satellite communication to transmit data, allowing for continuous monitoring of fishing activities and ensuring that vessels operate

within designated areas and comply with regulatory frameworks. VMS plays a crucial role in detecting unauthorized fishing activities, such as fishing in protected zones, and allows for prompt action to be taken when violations occur (Kauti & Ueda, 2016).

In addition to VMS, radar technology and the Automatic Identification System (AIS) have proven to be effective tools for enhancing fishery supervision. Radar systems provide the ability to detect and track the movement of vessels, even in areas with limited visibility, such as fog or at night. AIS, on the other hand, is a communication system that automatically broadcasts a vessel's position, speed, and course . By integrating these technologies, authorities can gain a comprehensive view of fishing vessel movements, which aids in identifying suspicious behavior, such as boats operating without proper identification or engaging in illegal activities.

Remote sensing technologies and artificial intelligence (AI) have also made significant contributions to the field of fishery supervision. Remote sensing involves the use of satellites and drones to capture high-resolution images of the ocean's surface, enabling the detection of illegal fishing activities even in remote and vast areas. AI is increasingly being integrated into these technologies to analyze data and identify patterns in fishing behavior, further improving the accuracy and efficiency of monitoring systems. By combining these advanced technologies, authorities can gather critical evidence of violations and enforce regulations more effectively, ultimately promoting the sustainability of marine ecosystems and the long-term viability of the fishing industry.

3.   Vessels Monitoring Systems (VMS)

Illegal fishing is one of the problems faced by many countries in the world, including Indonesia. Illegal fishing give rise to lots loss, good from facet economy, environment, and social. Government Indonesia through Ministry Marine And Fishery (KKP) has make various efforts to overcome the problem of illegal fishing. Wrong the only one supported by device advanced technology which known with Vessels Monitoring Systems "VMS" or System Supervision Boat Catcher Fish (SPKP).

VMS is system tracking based satellite which possible monitoring the position, speed and direction of ship movement in real-time. VMS data can used for ensure boat operate in accordance permission which given, detect activity arrest fish in zone forbidden or on time which forbidden, and identify pattern behavior which no in accordance with practice arrest fish which responsible answer. Use VMS Also is a form of Indonesia's commitment to comply with international, regional and international regulations national regulations regarding fisheries conservation and management sustainable. Since 2003, VMS was implemented by installing transmitter on sized fishing vessels more than 30 GT. VMS not only monitors the movement of fishing vessels, but also ensure compliance with the provisions applicable (Digarse & Patil, 2017; Jalilian et al., 2016; Liu et al., 2018).

By because that, based on Regulation Minister Marine And Fishery Number 42/PERMEN-KP/2015 concerning Fishing Vessel Monitoring System, fishing vessels measuring over 30 GT operating in the territory of the Unitary State The Republic of Indonesia must operate in the National Fisheries Management Area (WPPNRI), transmitter VMS must installed in sea free. Implementation very important for help reach continuity source power fishery and ensure that these resources can be used sustainably for interest public local.

Although Vessels Monitoring Systems (VMS) own benefit in supervision activity fishery, there is a number of weakness which need noticed, between others: Information Limitations: Information generated by VMS Possible own limitations in scope activity

boat. A number of activity boat Possible No covered fully in information which accepted, so that the analysis carried out may be incomplete, Vulnerability to Manipulation: Although VMS designed for monitor ship movement accurate, the system remains vulnerable to manipulation. It is possible that the owner boat or administrator can try for trick system with method turn off or manipulate transmitter VMS.

4.   Humanless Underwater Sensors Technology (HUST)

Humanless Underwater Sensors Technology (HUST) is an innovative technology designed to monitor underwater environments without the need for human presence. Unlike traditional methods, which rely on divers or crewed vessels, HUST utilizes sensors placed underwater to gather crucial data about various environmental conditions. These sensors measure parameters such as temperature, pressure, acidity (pH), and the presence of hazardous chemical materials, as well as monitoring the behavior and presence of marine organisms. This technology allows for real-time data collection in environments that are otherwise inaccessible or hazardous for humans to explore.

One of the major advantages of HUST is its ability to access deep-sea regions, remote underwater locations, and areas considered too dangerous for human exploration. It can reach depths and territories that are difficult to monitor through conventional means, such as ship-based surveys or human divers. This capability is especially useful in exploring the ocean's depths, monitoring sensitive ecosystems, and gathering data from isolated or hazardous zones, which would otherwise require expensive and time-consuming human interventions.

In addition to providing better access to challenging environments, HUST offers significant cost and time savings compared to traditional underwater survey methods. Without the need for a crew or diving equipment, the use of underwater sensors reduces operational costs and eliminates the risks associated with human involvement in potentially dangerous conditions. These benefits make HUST an appealing solution for a wide range of applications, from environmental monitoring and research to fisheries management and underwater exploration.

HUST operates using various types of sensing mechanisms, each designed to serve specific purposes in underwater monitoring. For example, seismic sensors detect vibrations on the sea floor, providing valuable information about underwater geological activity. Metal detectors can identify approaching ships, contributing to the monitoring of maritime traffic and illegal fishing activities. Additionally, ID sensors can detect and verify the identification of vessels in restricted areas, helping enforce regulations and manage fisheries effectively. With these advanced sensing capabilities, HUST is expected to improve the accuracy and reliability of underwater monitoring systems, supporting more efficient and sustainable management of marine resources.

5.   Technology Sensing Far (Remote Sensing)

Remote sensing technologies, such as satellite imagery and radar, have become invaluable tools for monitoring fishing activities over vast areas. Satellite imagery, in particular, can detect the presence of vessels at sea, including smaller boats that may not be equipped with Vessel Monitoring Systems (VMS). This capability allows authorities to track fishing activities in regions where traditional monitoring methods might not be as effective. Satellite imagery can also cover large geographical areas, making it an ideal solution for monitoring remote or hard-to-reach locations, which would otherwise require extensive human resources or vessel deployment (Godenau & López-Sala, 2016; Sivaramaganesh et al., 2014). Radar technology, on the other hand, plays a critical role in

detecting ships even under challenging conditions, such as at night or during poor weather. Radar systems can provide real-time data on vessel movements, making it easier to identify suspicious or illegal activities, even in low-visibility situations. This feature is particularly useful for detecting vessels that may be attempting to operate under the cover of darkness or adverse weather conditions, which would otherwise make them difficult to track using other methods.

The integration of satellite imagery and radar data allows for comprehensive analysis and monitoring of fishing activities. By analyzing satellite imagery, authorities can identify unregistered vessels that are operating without the required VMS, which helps ensure compliance with fishing regulations. Additionally, these technologies can be used to detect the use of prohibited fishing gear, such as illegal nets or trawling devices, by analyzing wave patterns or sea surface temperature changes caused by such equipment. This level of detail enables more effective enforcement of fishing laws and contributes to the protection of marine ecosystems.

Furthermore, remote sensing technologies can provide valuable insights into environmental conditions at sea, such as sea surface temperature, salinity, and chlorophyll levels. These parameters can be used to monitor the health of marine ecosystems and track the movement of fish stocks, which is crucial for sustainable fisheries management. By combining satellite imagery, radar, and environmental data analysis, remote sensing technologies offer a powerful and efficient means of monitoring fishing activities and supporting the sustainable management of ocean resources.

6. Studies Case Sea Natuna: Context and Challenges

Waters sea Indonesia which wide contain lots source power fishery. A wealth of sources fisheries power in Indonesian waters clear interesting attention of foreign parties, who may also exploit it illegally through illegal fishing activities (Lammertink et al., 2003). This illegal fishing activity is carried out by foreign fishermen from neighboring countries who enter illegally into Indonesian waters. Through various approach, fisherman foreign capable catch fish in waters Indonesia and sell it to outside Indonesia for get profit which significant (Darwis & Putra, 2022; Karnova, 2017). not only endangers fisheries resources sea Indonesia, but also reducing productivity and fish catches significantly, thereby causing harm to state finances . Foreign fishermen often enter into Indonesian waters come from countries such as Thailand, Vietnam, the Philippines, and Malaysia. Sea Natuna, Sea Sulawesi North, Sea Maluku, And sea Arafura is region which most affected by the activity illegal fishing.

Natuna Sea, which is located on the border between Indonesia, Malaysia, and Vietnamese, have wealth source power fishery which overflow. However, This wealth also makes it vulnerable to illegal fishing. The size of the area sea, limitations source power supervision, and complexity problem transnational becomes a challenge alone in the effort tackle illegal fishing in the Natuna Sea. Another challenge is overlapping claims over the sea area Natuna by a number of country.

This can make it difficult to enforce laws against foreign ships which do illegal fishing in the region the. Besides that, practice illegal fishing often involves organized criminal networks that have sources power and technology advanced for avoid detection and arrest. This meaning, illegal fishing activities that occur in Indonesian Natuna waters, which carried out by foreign fishermen, can be interpreted as a traffic crime state (transnational crime) because its activities and networks are cross-border; the actors involved and their various activities transcend national borders. Activity illegal which nature cross limit this become problem Serious for Indonesia.

CONCLUSION

Illegal fishing is a significant issue that not only threatens marine ecosystems but also poses economic and social challenges to local communities. The depletion of fish stocks due to illegal fishing practices impacts the livelihoods of legitimate fishermen and disrupts the sustainability of fisheries. Destructive methods, such as the use of explosives or banned trawling techniques, further exacerbate the problem by damaging marine habitats and undermining the delicate balance of marine ecosystems. This cycle of ecological imbalance also jeopardizes the long-term viability of the fishing industry, highlighting the urgency for stricter enforcement of regulations.

Technological advancements have played a crucial role in enhancing the supervision of fisheries and combating illegal fishing. Systems such as Vessel Monitoring Systems (VMS), radar, Automatic Identification System (AIS), and satellite imagery enable real-time tracking of vessels and detection of illegal activities in remote areas. These technologies allow for more efficient enforcement of fishing regulations and the protection of marine resources. The integration of artificial intelligence and remote sensing technologies further improves the ability to monitor large areas and detect suspicious behaviors, making them invaluable tools for fisheries management.

However, despite the technological progress, the fight against illegal fishing remains a complex challenge, especially in regions such as the Natuna Sea, where overlapping territorial claims and transnational criminal networks complicate enforcement efforts. The illegal activities in these areas are often carried out by foreign fishermen with advanced technologies, making detection and enforcement even more difficult. As a result, international cooperation and continued technological innovation are essential in addressing the root causes of illegal fishing and ensuring the long-term sustainability of marine ecosystems. Addressing this issue will require a combination of technological advancements, stronger legal frameworks, and collaborative efforts.

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