



Chlorophyll-A Image as a Guideline for the Establishment of Illegal Fishing Control Areas Case Study North Kalimantan Waters

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Abstract. This study would like to raise how each agency establishes a method for determining the area of control, advantages and constraints of the applied method, and measuring how the chlorophyll-a image to serve as one of the guidelines for determining the areas of illegal fishing surveillance. Researcher used qualitative descriptive method in this research and the data used derived primary and secondary data resources. The results of this study indicate that there are still obstacles to apply the methods used by some agencies, but to cover these constraints every institution diligently share data, information and coordinate each other, both regional and national scope. The most widely used VMS data is considered to be in short supply because it is considered to be ineffective in North Kalimantan because the ships in North Kalimantan do not all have a size above 30 GT. The second finding based on data in the field that has been processed into the map seen the existence of the linkage between chlorophyll-a content with the catching areas that occurred illegal fishing action, so that the image of chlorophyll is considered suitable to be one of the guidelines for determining illegal fishing surveillance area.

Keywords: Surveillance · Illegal fishing · Guideline · Chlorophyll-a

1 Introduction

Indonesia is located between two oceans, namely the Indian Ocean and the Pacific Ocean, has a coastline of 81,000 km, and the sea area including the Indonesian Exclusive Economic Zone (EEZ) is 5,866 million km². However, along with the many potentials that Indonesia has, especially the potential for capture fisheries, more and more problems will be faced, and a very crucial problem is the problem of illegal fishing. Indonesia suffers losses of up to 30 trillion per year only from the practice of IUU fishing. The magnitude of the losses experienced from the practice of IUU fishing can pose a threat

from a security perspective that has implications for economic security, energy security, and food security.

Based on a security perspective, the development of issues in the maritime domain, especially illegal fishing, is a non-traditional threat. In the context of maritime security in Southeast Asia, traditional threats are often defined as disputes over maritime boundaries that can lead to armed (military) conflict at sea [1]. Meanwhile, non-traditional threats in the context of maritime security are threats that come from non-state actors or the perpetrators are not from state institutions, but groups that commit crimes at sea. This threat can directly affect Indonesia's strategic environment. Around 47% of the world's fish stocks are currently fully exploited, 18% are overexploited, and 10% are depleted. This data shows that the world's fishery stocks have been decreasing [1], this has caused Indonesian waters to be the target of fishing theft by other countries as well as by fishermen from their own country.

Sebatik Island is one of the islands in North Kalimantan Province which is located in WPP-RI (Fisheries Management Region of the Republic of Indonesia) 716 which has a diversity of fishery resources that have high economic value which is also a land for illegal fishing by foreign fishermen. In February 2015 two ships were caught committing illegal fishing in the waters of Karang Unarang, North Kalimantan[1].

Patrol activities that are currently being carried out by several stakeholders to handle illegal fishing cases find several obstacles in their implementation, the obstacles experienced in the implementation of fisheries supervision, especially in this case is the handling of illegal fishing, one of which is the limited human resources in the field of fisheries investigators, facilities and infrastructure. Inadequate, and lack of coordination between stakeholders. In Attempt to reduce these problems, a method of determining the patrol path is needed in order to reduce the load and increase the efficiency of the patrols carried out. One of them is using remote sensing technology to obtain chlorophyll-a images which have been used to determine the distribution area of fish, to be used as a benchmark for determining fishing grounds [2]. The image of Chlorophyll-a was obtained through the results of the detection of the Aqua-MODIS satellite, which is one of the satellites commonly used for the field of oceanography.

Chlorophyll-a itself is a green pigment in plants that utilize sunlight and is needed by phytoplankton in carrying out the photosynthesis process. Phytoplankton act as primary producers or producers in the food chain in the waters. Furthermore, the phytoplankton will be eaten by the primary consumers and subsequent eaters. The high content of chlorophyll-a indicates that there are many natural food sources for fish. Fish tend to occupy areas that have high chlorophyll-a content because they are rich in nutrients[2].

In dealing with the rampant cases of illegal fishing that occur in Indonesian waters, relevant agencies have taken many preventive measures, including establishing regulations related to fisheries management, one of which is routine surveillance and patrols. However, there are still some obstacles, especially the unclear method for determining a monitoring area. Therefore we need a method of determining the surveillance area so that it can be an alternative solution for the problem. The image of chlorophyll-a has been used as a guide to determine fishing areas that also have the potential for illegal fishing to occur in these fishing areas.

Research conducted based on phenomena that occur in the field, focused on the location of North Kalimantan Province with a study focus in 2014–2017. So the purpose of this study is to analyze the chlorophyll-a image map that has been used to determine the distribution of fish, with a map of the distribution of illegal fishing crimes at sea and analyze the coordination between agencies and their efforts in determining the area of illegal fishing supervision.

2 Methods

In this study, researchers prefer to use descriptive qualitative research which aims to explain facts, phenomena, circumstances that occur naturally. So the researchers used this type of qualitative research method of analysis. In addition, researchers will interpret the data with situations that occur in the field. So, the researcher visited and conducted interviews with the relevant informants.

The data collection method used is in the form of searching data from various sources such as books, agency reports, journals, scientific papers, magazines, newspapers, internet which are closely related to illegal fishing and its handling, especially supervision, as well as through interviews with relevant agencies and sources of information that can be used. Trusted (academics, experts, and researchers). As well as collecting chlorophyll-a image data from the Aqua Modis satellite from 2014–2017.

Sources of data obtained through interviews are in-depth interviews to look for problems more openly and get more in-depth data. A literature study was conducted to obtain secondary data relevant to the issue of piracy, overlapping authorities that worsen the role and coordination of law enforcement agencies, such as journals, books, electronic media and print media. The purpose of the literature study is to support other data obtained through interviews.

The resource persons used in the study were determined by purposive sampling, namely the method of determining the informants based on the research objectives to be achieved and the capabilities of the resource persons in the problem. Subjects in this study, will be interviewed as a form of primary data collection through interviews with sources. Main sources, such as; Director General of PSDKP Ministry of Marine Affairs and Fisheries; Head of the Indonesian Maritime Security Agency (Bakamla); Commander of the Main Naval Base (Lantamal) XIII Tarakan, North Kalimantan; Director General of POLAIR (Waters Police), POLDA, North Kalimantan; and the Head of the Provincial Fisheries Service. North Kalimantan.

While secondary data in the form of data that will support the research. The data is obtained in the form of literature books and other sources.

3 Results

3.1 Chlorophyll-A Image as One of the Guides for Determining Monitoring Areas

Researcher will combine several data such as image data on the distribution of chlorophyll a, data on fishing areas and potential catch areas by the KKP, as well as data on the coordinates of the violation points obtained from the agencies that are the subject

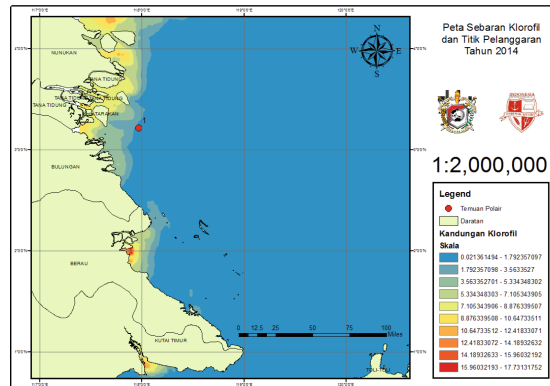


Fig. 1. Map of Chlorophyll-a Distribution and Violation Points in 2014 (Source Data processed by researchers)

of the study, then the data will be processed to become a map, so that it can be seen in which areas where illegal fishing occurs and what factors make the area a place for illegal fishing (Fig. 1).

Based on the data that was collected in the field on 2014 and then processed into a map and divided annually, the results of the map are as follows.

The picture above is a picture of the point of violation based on data found by Polair in 2014 namely a case of illegal fishing carried out by an Indonesian-flagged ship named KMN Rahmat Divine which committed a violation in the form of catching fish in the fishery management area of the Republic of Indonesia and did not have a SIPI (permit fishing) at the time of the violation, the Central Tarakan Polres Polair Satlanres conducted patrols in the waters of the Tarakan city area, when arrested the perpetrator was carrying out fishing activities, this illegal fishing act occurred around the waters of Muara Tarakan. It can also be seen in the picture above that the point of violation occurs in areas containing chlorophyll ranging from 1.79 to 3.56 mg/liter which indicates that the chlorophyll content in the waters where the violation occurred has a high concentration of chlorophyll with a high suspension charge. This is certainly in accordance with the theory put forward by [3], which states that the content of chlorophyll a in phytoplankton in a waters can be used as a guide to see the fertility of the waters And also stated by [4] that the content of chlorophyll-a in Plankton itself can be used as an indicator of the high and low productivity of a waters.

In 2015 data were obtained from two agencies, namely the Tarakan Police Polres Satlanres and Tarakan Lantamal XIII. The distribution of the data coordinates for illegal fishing violations is slightly different because the Tarakan Polres Polair Satlanres only carry out patrols in the waters around the city of Tarakan, while Lantamal XIII Tarakan patrols a little further to the north of Sulawesi (Fig. 2).

It can be seen in the picture above that the distribution of the coordinates of illegal fishing catches obtained from the Tarakan Polres Polair Satlanres is not much different from the 2014 data, namely the vessels caught only in the vicinity of the Tarakan City waters area which is a routine monitoring route by the Tarakan Polair Polres Satlanres,

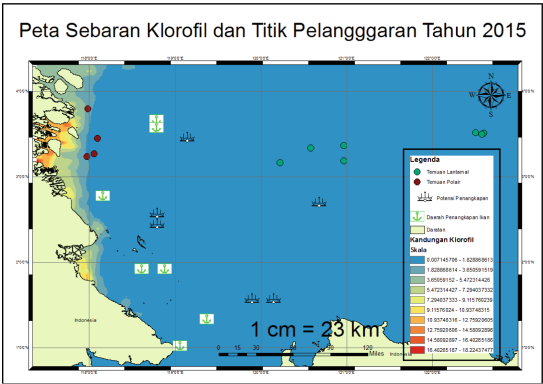


Fig. 2. Map of the distribution of chlorophyll-a and violations in 2015 (*Source* Data processed by researchers)

but if seen the distribution of illegal fishing catches based on data from Lantamal XIII Tarakan, the vessels caught were pumpboats with the Philippine flag, the map in the picture also includes one other variable, namely the coordinates of fishing areas and areas of fishery potential obtained from the Ministry of Marine Affairs and Fisheries. In the picture above, it can be seen that 4 points of violation based on data from Lantamal XIII Tarakan are near the coordinates of potential fishing grounds, while the other three coordinate points are located some distance from fishing areas and potential fishing areas, this is due to the habit of Philippine pumpboat vessels having 1 Motherboat waiting outside the EEZ so it was suspected that when they were caught the pumpboats were about to head to their Motherboard.

For 2016 researchers managed to collect 4 data on illegal fishing acts carried out by Philippine-flagged vessels, 3 of the 4 coordinate points of the arrest of violators by foreign fishing vessels in Indonesian waters based on data obtained from Lantamal XIII Tarakan is in direct contact with the coordinates of the fishing area. Fish in the waters north of Kalimantan. This proves that there is a correlation between the use of chlorophyll-a imagery to determine fishing areas and fishing activities, or indirectly the fishing activities found here are illegal fishing activities by foreign fishing vessels (KIA). Fish, and the distribution of violations can be seen in the image (Fig. 3).

The distribution of points of violation in 2017 of the 5 coordinates of violations obtained from the Tarakan PSDKP Station and Lantamal XIII Tarakan data are all violations committed by foreign fishing vessels, four of which are Malaysian-flagged which were caught by the Tarakan PSDKP Station agency in the waters east of Sebatik island located in areas that have chlorophyll-a content ranging from 0.001 to 4.24 MG per liter and are also close to the coordinates of potential fishing areas. The high concentration of chlorophyll-a proves that fishing activities are indeed carried out in areas that have a high level of water fertility, in line with [6] who stated that the presence of chlorophyll-a is an indication of the presence of fish [7] (Fig. 4).

In 2017 researchers obtained one coordinate point from the data of Lantamal XIII Tarakan which is a bit far from a place that has a high chlorophyll concentration as well as a coordinate point for potential fishing areas, but according to the data, the violation

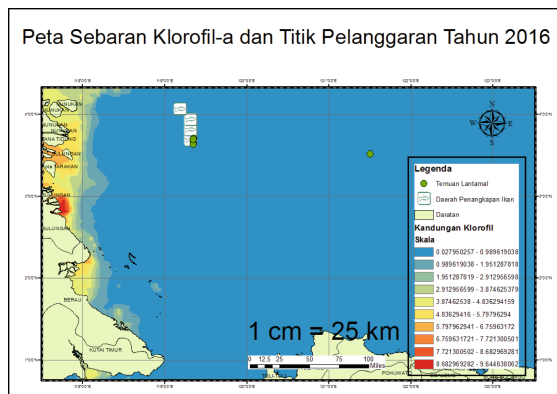


Fig. 3. Map of Chlorophyll-a Distribution and Violation Points in 2016 (*Source Data processed by researchers*)

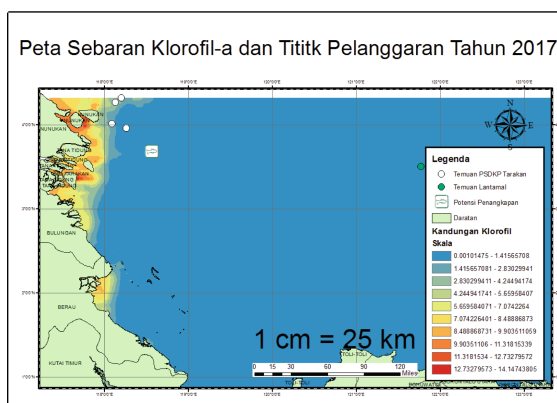


Fig. 4. Map of Chlorophyll-a Distribution and Violation Points in 2017 (*Source Data processed by researchers*)

that occurred at this coordinate point was carried out by FB Shiekka with a Philippine flag and when the fishing vessel is caught, the foreign fishing vessel is carrying out fishing activities, as for the violation committed by the vessel, it is in possession of a Document [8].

Based on data that has been processed into maps from 2014 to 2017 it can be seen that there is a direct or indirect relationship between chlorophyll-a which is an indicator of the level of water fertility and illegal fishing activities that occur, especially in the waters of North Kalimantan which directly borders with 2 neighboring countries, namely Malaysia and the Philippines. With this, the image of chlorophyll-a is considered to be one of the guidelines for planning surveillance areas in order to maximize the realization of maritime security, which is based on 5 state perspectives in creating maritime security, one of which is “Security of Sea Itself”, namely the creation of a free Indonesian maritime domain condition. From threats. This certainly can be considered by agencies that have

not used chlorophyll a imagery as one of the guidelines that are taken into consideration in determining the monitoring area. Until now, several agencies have not used chlorophyll a imagery as a guide for determining surveillance areas.

3.2 Coordination Between Agencies and Efforts in Determining the Control Area for Illegal Fishing Handling

IUU fishing as it is known is one of the non-traditional maritime security threats of a country that can have a major impact on the security and sustainability of resources, especially Marine and Fishery resources. Lately, all problems related to the maritime domain have become the focus of the government of the era of President Joko Widodo, both in terms of resource utilization, as well as defense and security. Illegal fishing is a threat that cannot be taken lightly, from 2014 to 2017 based on data collected by researchers, there have been 31 violations, 29 of which were illegal fishing with 23 cases carried out by foreign fishing vessels, both Malaysian and Filipino flags. is the closest area to the research area, namely in the territorial waters of North Kalimantan Province, while the other 2 cases are cases of crab smuggling from Indonesia to Malaysia. This of course can cause insecurity and local fishermen feel disadvantaged, therefore this study discusses the methods of relevant agencies in carrying out surveillance to realize a maritime security as described in Rahman 2009, there are 5 perspectives used by the state - the state in creating maritime security, among others; Security of the sea itself, Ocean Governance, Maritime border protection, Military activities at sea and Security regulation of the Maritime transport system.

Based on these circumstances, it can be said that maritime security is a condition in which good ocean governance is created.

In this study, researchers took 6 research subjects including the Directorate General of PSDKP, Ministry of Maritime Affairs and Fisheries, Tarakan PSDKP Station, Sebatik-Nunukan PSDKP Supervisory Unit, Tarakan Police Polair Satlanres, Tarakan Lantamal XIII, and Bakamla. Each of these agencies is deemed suitable to be the subject of research because it has a main function, one of which is to enforce the law of the sea, especially in the field of fisheries, to create the realization of a maritime security as described in Rahman 2009, that the main element of creating maritime security is the actions taken. by the government in dealing with maritime security threats so that the sea can be utilized effectively.

These six agencies have an important role in creating a maritime security condition and also play an important role in eradicating IUU Fishing. IUU Fishing itself as classified by IPOA-FAO is divided into three types, namely illegal fishing, unreported fishing, and unregulated fishing. In this study, researchers will discuss more about how each agency establishes a method to determine the area of supervision, in this case the area of supervision of illegal fishing. Researchers will discuss more about how each agency establishes a method to determine the area of supervision, especially the area of supervision of illegal fishing.

Researchers found 31 cases of IUU fishing in the field, 29 cases of which were illegal fishing by domestic and foreign vessels, as classified by IPOA-FAO, the perpetrators of illegal fishing were domestic fishing vessels, foreign fishing vessels, and ships from countries that are members of the RFMO. As for the 29 illegal fishing cases found in the

field, all of them carried the characteristics of violations as classified by the IPOA FAO, namely carrying out arrests without a permit, violating laws and regulations, contrary to national regulations and international obligations.

Agencies that are research subjects have different areas of authority to realize stable ocean governance, starting from agencies that have national areas of authority such as the Directorate General of Supervision of Marine Resources and Fisheries, the Ministry of Marine Affairs and Fisheries and the Marine Security Agency which has an area of authority in all Indonesian waters and Indonesian jurisdictions, and several other agencies have their own areas of authority such as Lantamal XIII Tarakan which has an area of authority in accordance with several Lanals under Lantamal XIII Tarakan, Satlanres Polair Polres Tarakan which has an area of authority in the waters around the city of Tarakan, Tarakan PSDKP Station which has a working area based on several units under the Tarakan PSDKP Station, and Sebatik-Nunukan PSDKP Satwas which has a working area in the waters around Sebatik and Nunukan.

Each agency has different methods in determining surveillance areas related to illegal fishing, there are several agencies that use data integration methods in the form of VMS data, AIS, satellite photo images and chlorophyll a images. However, there are also several agencies that still use conventional methods such as determining the area of supervision based on the level of vulnerability, working area, and community reports. The use of VMS data, AIS, satellite imagery and chlorophyll imagery is a method of using remote sensing to monitor conditions on earth, especially in the maritime domain, both ship movement and fishing potential, this method is an embodiment of the concept of Maritime Domain Awareness, according to [6] Maritime Domain Awareness is the ability to continuously monitor all aspects of state interest in the maritime area such as ships, cargo, passengers, crew, and others [9]. Not only limited to the technical side of the realization of Maritime Domain Awareness among law enforcement agencies at sea, especially in the case of surveillance of illegal fishing in the North Kalimantan region, it also creates an information exchange which according to [6] to achieve Maritime Domain Awareness, requires exchange and information integration and sense-making with the aim of providing responsive intelligence data and operational coordination directed by policy makers supported by relevant maritime legislation and strategic maritime policies.

The realization of the Maritime Domain Awareness concept in terms of exchanging information and data is also carried out by the Tarakan XIII lantamal agency which has a system called the Integrated Maritime Surveillance System (IMSS) which is used by naval institutions in general to conduct security surveillance at sea. Bakamla also explained that Bakamla routinely shares information and shares data between relevant agencies to improve supervision in Indonesian waters and Indonesian jurisdictions, Bakamla performs data integration by collecting all data such as VMS data from KKP, AIS data from Bakamla, reports collected from the community which is then collected at the Bakamla data and information center (pusdatin). Bakamla also routinely conducts coordinated patrols between agencies related to the supervision of resources, especially fisheries. Not only agencies with a wide surveillance area that share and integrate data, but agencies that have small or local surveillance areas such as the Tarakan PSDKP Station, Tarakan Police Polair Satlanres and Sebatik Nunukan PSDKP Satwas also routinely exchange information and coordinate between related agencies.. Based

on the researcher's interview with one of the institutions that became the research subject, namely Tarakan PSDKP Station with resource person Hamzah Kharisma, S.St.Pi., he explained that so far the Tarakan PSDKP station often coordinates between agencies because the Tarakan PSDKP Station really needs information from other agencies deemed to support operational planning [10].

In carrying out these methods of supervision, these agencies also experience several obstacles, while the obstacles faced by these agencies are:

1. The Directorate General of PSDKP KKP has obstacles in the form of elemental strengths that are not in accordance with the area being monitored, so they have to ask for help from other agencies.
2. PSDKP Tarakan Station has problems in the form of cessation of cooperation with Indesso which supplies satellite photo images to plan the operating area, datavis is considered ineffective because there are not many ships above 30 GT in the supervision area of PSDKP Tarakan Station, travel efficiency related to fuel and operating time.
3. PSDKP Satwas Sebatik-Nunukan has obstacles in the form of an inadequate fleet to carry out further supervision.
4. The Tarakan Polres Polair Satlanres have constraints in the form of a lack of fleet and budget constraints.
5. Lantamal XIII Tarakan has problems in the form of Lack of Fleet.
6. Bakamla has problems. Not being able to focus only on overseeing Marine and Fisheries resources.

In dealing with these obstacles, of course, it is necessary to implement a good Maritime Domain Awareness system, such as information exchange and improvement of stakeholders so that optimal information exchange can be established. This effort has been carried out by agencies such as the Tarakan PSDKP Station which coordinates with the Tarakan Polres Polair Satlanres and Tarakan Lantamal XIII in an effort to secure fishery resources. Limitations in applying the concept of Maritime Domain Awareness to conduct security surveillance in the maritime domain have a significant impact as evidenced by the obstacles experienced by the Tarakan PSDKP station as evidenced by the experience of the Tarakan PSDKP Station which had used satellite imagery from Indonesia which increased the effectiveness of surveillance, but now based on a statement from resource persons when cooperation between KKP and Indeso ceased to exist, the Tarakan PSDKP Station agency carried out patrols by means of sea saws which of course was burdensome considering the limited fleet owned by the Tarakan PSDKP station. The satellite photo image which is the result of the collaboration between the KKP and the Indesso is considered quite effective because the ships that make the most arrests are the ships that are diligent in coordinating with the Indesso service desk which intensively provides feedback [11]. The same thing is felt by the PSDKP Sebatik Nunukan supervisory unit which does not yet have the availability of remote sensing data such as VMS data, AIS, satellite photo images and chlorophyll-a images, this is certainly burdensome for the PSDKP Sebatik Nunukan supervisory unit considering the lack of use technology related to sensing and exchanging information as explained by [6], that the exchange and incorporation of information is very vital in Maritime Domain Awareness.

However, this is somewhat covered by the good cooperation between agencies carried out by the PSDKP Sebatik Nunukan supervisory unit.

Indonesia's steps to realize the Maritime Domain Awareness concept are considered to have been carried out well with the Bakamla agency, because the role of Bakamla itself is one of which is to synergize and monitor the implementation of water patrols by related agencies as described in the Presidential Regulation of the Republic of Indonesia Number 178 of 2014 concerning the Maritime Security Agency. This was confirmed by a statement from a source from the Bakamla agency, namely Mr. Imam Hidayat as the Head of Sub-Directorate for the Implementation of Marine Operations, as well as a statement from the Ministry of Maritime Affairs and Fisheries agency of the Directorate General of PSDKP with Mr. M. Ichsan as the director of Fleet Monitoring and Operations, who explained that so far the patrols were coordinated or joint operations are handed over to Bakamla's leadership because according to sources, Bakamla's function is to organize or coordinate agencies for safety at the sea.

4 Conclusion

The waters of North Kalimantan Province which are included in WPP 716 are quite safe areas because based on the findings there were only 31 cases during 2014 to 2017 but what became of concern were 29 cases including illegal fishing with 23 cases carried out by foreign fishing vessels with Malaysian and Philippine flags., where Malaysia and the Philippines are countries whose seas are directly adjacent to the Indonesian sea.

Based on the data found in the field that has been processed into a map, it was found that there is a relationship between the content of chlorophyll-a and the fishing area where illegal fishing occurs. So that the use of chlorophyll-a imagery is appropriate to be used as a guide for determining surveillance areas.

Based on the findings in the field, each agency has carried out their respective functions very well and complemented the shortcomings and obstacles faced by sharing data and information as well as coordination between agencies to realize a maritime security. As has been done by the Tarakan Lantamal XIII agency which coordinates and shares data and information with the Tarakan Polres Polair Satlanres, Tarakan PSDKP Station, and the Tarakan City Fisheries Service. And for the national scope, the Directorate General of Marine and Fishery Resources Supervision of the Ministry of Maritime Affairs and Fisheries also routinely carries out joint patrols between related agencies coordinated by Bakamla.

In order to determine the method of supervision, especially the supervision of Marine and Fishery resources, each agency has carried out different plans, both using remote sensing data, intelligence data, and also using the benchmark area of authority as a guide for determining the monitoring area. The most widely used remote sensing data are VMS (Vessel Monitoring System) and AIS (Automatic Information System) data, satellite photo image data and chlorophyll-a image data, however, the use of chlorophyll-a image data has only been implemented in Bakamla agencies. Each method has its own advantages and disadvantages as well as VMS, to be applied in the North Kalimantan area is considered less effective because there are not many ships above 30 GT that install VMS in the waters of North Kalimantan. And the satellite imagery, which is currently

the end of the collaboration, so that it is burdensome for several agencies considering the constraints of the Fleet and personnel elements.

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