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Unveiling Status of Demersal Fisheries in Tegal City, North of Jawa: Application DPSIR Framework Approach

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ABSTRACT

Demersal fish resources are an important fisheries commodity in the Java Sea. The Tegalsari Coastal Fishing Port serves as the primary landing site for demersal fish caught using mini trawls, locally known as *cantrang*. This port plays a key role as a central hub for *cantrang* fisheries and is a major supplier of fish catches in Central Java Province, contributing significantly to the region's economic, social, and environmental dynamics. Economically, the large volume of demersal fish caught using *cantrang* nets has increased fishermen's income. However, this fishery has also created social tensions, particularly for fishers who use alternative, less destructive fishing gear. From an environmental perspective, the use of *cantrang* nets has contributed to over-exploitation and a decline in fishery resources. This study aimed to formulate effective management measures for the *cantrang* fishery by applying the DPSIR (Driver–Pressure–State–Impact–Response) framework. The results demonstrate that the DPSIR framework effectively illustrates the interconnections between social, economic, and environmental factors. These relationships emerge from driving forces that lead to environmental changes and degradation. The resulting impacts include a decline in the potential yield of fishery resources, leading to reduced fish catches for local fishers. To mitigate these issues, it is essential to implement sustainable fisheries management practices, promote the use of environmentally friendly fishing methods, and diversify raw materials for surimi production.

INTRODUCTION

The Java Sea is one of Indonesia's marine areas that has considerable marine resource potential. It has been utilized for various purposes, including supporting the livelihoods of capture fisheries communities on the north coast of Java. The potential yield of demersal fish in the Java Sea is estimated at around 358,832 tons per year, with a utilization rate more than one, which means that the exploitation rate is at an overfishing level **(MMAF, 2022)**. Demersal fish resources have been exploited using various types of fishing gear, including gill nets, trammel nets, and mini trawl nets locally known as *arad*,

dogol, and *cantrang* **(Sumiono *et al*., 2002; Nugroho *et al*., 2017; Wulandari *et al*., 2021; Taurusman *et al*., 2025)**.

The biodiversity and abundance of demersal fish resources in the Java Sea have been intensively exploited using various fishing gears, including trawling gear in previous years. Following the ban on trawl operations, fishers along the northern coast of Java modified trawl nets into mini trawl types locally known as *cantrang*, *dogol*, and *arad*. These fishing gears are considered environmentally harmful due to their destructive impact on marine habitats.

In response, the Ministry of Marine Affairs and Fisheries (KKP) introduced regulatory measures, including the issuance of Ministerial Regulation (Permen KP) Number 2 of 2015 concerning the Prohibition of the Use of Hela Trawl and Trawl Fishing Gear, and Permen KP Number 71 of 2016 regarding Fishing Routes in Indonesia's Fisheries Management Areas. These regulations established a moratorium on the use of such destructive fishing gear.

The moratorium was driven by several critical factors. Among them was the downscaling of fishing vessel sizes in 2015, which reportedly caused an economic loss of approximately IDR 10.44 trillion. Additional losses included an estimated IDR 328.41 billion from reduced non-tax state revenue (PNBP), misuse of subsidized fuel for fishing vessels amounting to around IDR 280.09 billion, and the depletion of fishery resources valued at approximately IDR 9.83 trillion **(Raharja, 2020)**.

The prohibition on the use of trawling gear has not been implemented effectively and has led to significant controversy. The ban had negatively impacted industries relying on catches, including fishermen who operate trawl gear, and has also decreased the number of demersal fish catch **(Hanum *et al*., 2021)**. Furthermore, there has never been a grace period provided by the government for the process of transitioning to alternative fishing gear. However, the government issued a policy in 2020 to extend the ban on *cantrang*, *arad*, and *dogol*, allowing fishermen the opportunity to use the different types of fishing gear.

The Tegalsari Coastal Fishing Port is one of the primary landing centers for demersal fish in the Java Sea, where *cantrang* nets are commonly used. This port is located in Central Java Province. Demersal fish resources play a crucial role for the communities in Central Java, serving both as a major source of livelihood and as a staple for local consumption. However, the increasing size of the fishing fleet and the number of fishing units have led to intensified fishing activities, which are often poorly regulated. This includes a rise in both the number of fishing gears and the frequency of fishing trips **(Wiadnyana *et al*., 2017)**.

According to fisheries statistics from 2019 (https://statistik.kkp.go.id), the northern waters of Central Java accounted for 25.93% of the total demersal fisheries production, with 43.66% of the total fishing gear operating in Fisheries Management Area (FMA) 712. This suggests that the significant increase in fishing effort in these waters has not

been accompanied by a corresponding increase in catch. The decline in catch volumes is considered an indicator that fishing activities may be exceeding sustainable limits **(Widodo & Suadi, 2006; Suman *et al*., 2018)**.

Another issue is highlighted by various research findings. Non-selectivity in the utilization of demersal fish is a factor that affects the resilience of demersal fish in the coastal waters of Central Java **(Nugroho, 2018)**. **Nugroho (2018)** reported that the average adult length of *kuniran* (*Upeneus* spp.) is approximately 20cm; however, fish caught using *cantrang* nets were found to measure only 6.41cm, indicating the capture of individuals well below the mature size. The estimated Spawning Potential Ratio (SPR) of *Upeneus* spp. is 18%, which falls below the biological limit reference point of 20%, indicating that overfishing has occurred **(Zamroni & Widyastuti, 2019)**. The use of *cantrang* nets in the northern waters of Java is largely non-compliant with the standard construction criteria for trawl nets **(Riyanto *et al*., 2011; Sasmita *et al*., 2012; Afandi & Zainuri, 2020)**.

Furthermore, **Sukandar *et al.* (2015)** reported that the prohibition of trawl nets resulted in a 30% reduction in potential fishery yields. However, the ban also had significant socioeconomic consequences. Following the trawl net ban, communities experienced increased unemployment, declining welfare, and a rise in crime rates **(Ermawati & Zuliyati, 2015)**. The government's policy banning the use of *cantrang* nets has therefore had a considerable impact on both the economic and social conditions of affected fishers **(Sari & Brata, 2017; Hendrayana & Hartanti, 2018)**.

Based on the issues outlined above, this research aimed to formulate effective management strategies for the *cantrang* fishery based at the Tegalsari Coastal Fishing Port in Central Java. The study employs the DPSIR framework (Drivers–Pressures–State–Impact–Response), as proposed by **Smeets and Weterings (1999)**, to assist policymakers in interpreting interconnected environmental, social, and economic information. This approach is intended to help identify the underlying driving forces and pressures, assess current conditions and impacts, and develop appropriate policy responses to address the problems identified.

Furthermore, this study supports the achievement of the Sustainable Development Goals (SDGs), particularly SDG 14, which emphasizes the conservation and sustainable use of oceans, seas, and marine resources for sustainable development.

MATERIALS AND METHODS

Study site and time

The research was conducted in the city of Tegal (Fig. 1). The determination of the research location was motivated by the significant contribution of demersal fish production in that area to the total demersal production in Central Java. Data collection was carried out from July 2022 to August 2023.

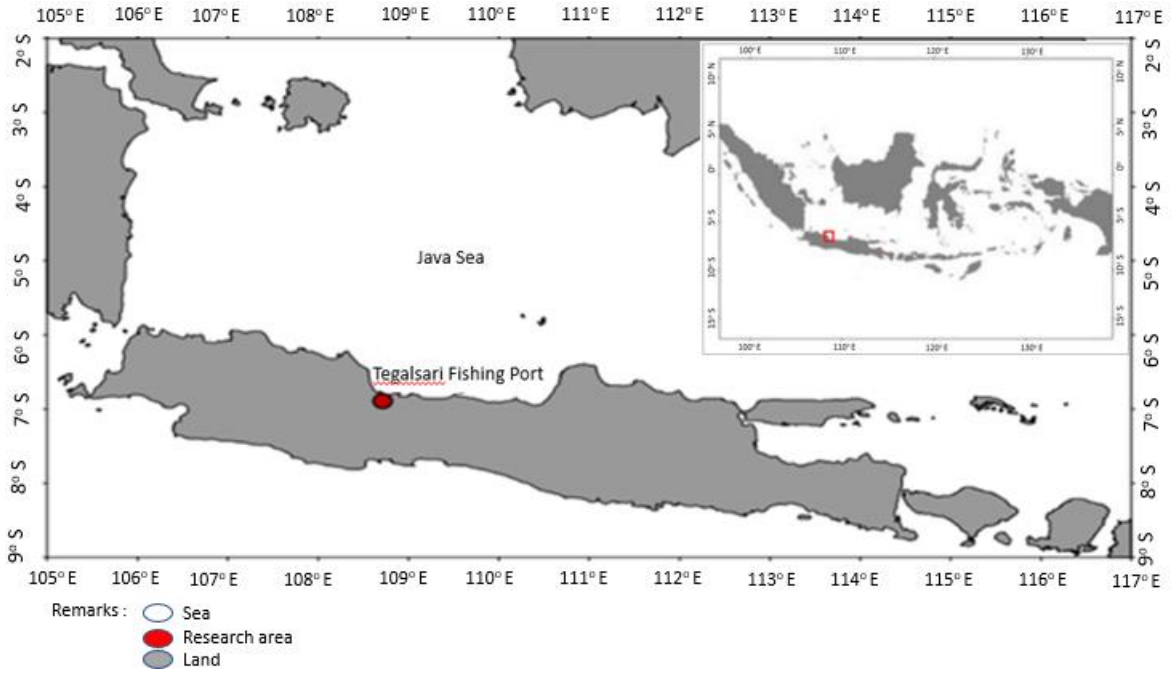

Fig. 1. Map showing research location at Tegalsari Fishing Port, Central of Java, Indonesia

Study approach

This research is a case study concerning the dynamics of demersal fisheries in Tegal City, Central Java, with the implementation of the government's moratorium on the use of *cantrang* net. The study uses the DPSIR framework approach (Driving forces (D), Pressures (P), State (S), Impacts (I), and Responses (R)).

The DPSIR framework approach was first applied in Europe in 1993 by the Organization for Economic Co-operation and Development (OECD) and was widely utilized by the European Environment Agency in 1995 as well as the U.K Environmental Agency. This framework is used for identifing causative relationships between environmental systems and human systems. Furthermore, it aims to assist policymakers in understanding relevant information **(Kristensen, 2004)**.

The focus of this research was on formulating strategies or action steps for the utilization and management of demersal fisheries in Tegal City, Central Java, which is outlined within the framework of Drive (D), Pressure (P), State (S), Impact (I), and Response (R). Data were collected through observations and perceptions of stakeholders related to the policies on the use of cantrang net in relation to biological, technological, social, economic, and institutional conditions. The data and information were then analyzed to differentiate between driving forces, pressures, states, impacts, and responses. The study also discusses the actions that have been and are being undertaken by the community and government to address these issues.

Data collection and data analysis

The DPSIR framework approach was carried out through a qualitative descriptive approach. The method used in this research is the qualitative descriptive method, which aims to gain a deep understanding of existing phenomena, facts, or realities **(Raco, 2010)**. DPSIR is understood to be based on the causal relationships where societal drivers generate pressures within the human society, pressures affect the states, states cause response, and reactions in turn influence each of the four other factors **(Lee *et al*., 2010; Putra *et al*., 2020)**.

Field data collection was carried out through surveys and direct observations. Data and information were gathered through in-depth interviews with 16 individuals consisting of 10 fishermen, 2 traders, 2 industry owners, and 4 relevant officials. Secondary data were obtained from the Tegalsari Coastal Fishing Port, Marine Fisheries Agriculture and Food Service of Tegal Central Bureau of Statistics of Tegal, and other related organizations. Data and information were also supplemented by previous research studies and literature reviews.

The research framework is conducted based on several stages, namely:

- The stages of the research begin with an understanding of the problems occurring in the utilization and management of demersal fisheries in Tegal City, Central Java at present, through observations, in-depth interviews, and literature studies. The identification of issues encompasses four aspects, namely biology, technology, socio-economics, and institutional factors (state).
- The second stage involves conducting a focused group discussion (FGD) to explore the triggering factors and pressures that are the causes, as well as the resulting impacts (drive-pressure-impact).
- Based on the analysis of the results at the DPSI stage, the next step is to formulate strategic actions that can be taken to address the existing issues (response). The DPSIR framework approach (Driver - Pressure - State - Impact - Response) is illustrated in Fig. (2).

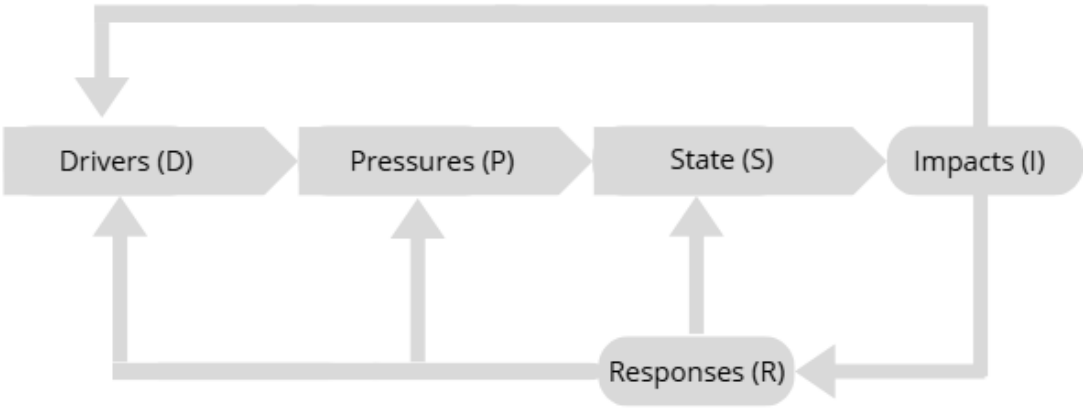

Fig. 2. DPSIR (Driver – Pressure – State – Impact – Response) analysis Framework

RESULTS AND DISCUSSION

The DPSIR framework encompasses the driving factors and pressures that cause problems to arise, along with the impacts and the measures that should be taken to address these issues (Driver - Pressure - State - Impact - Response). Therefore, the results and discussion will first present the current conditions along with a description of the problems that are occurring (State). Subsequently, the factors that trigger issues and the existing pressures will be outlined (Driver - Pressure), as well as the resulting impacts (Impact). Finally, strategies or measures will be formulated to provide solutions to the problems and impacts (Response).

1. States

The state describes the current condition of demersal fisheries at the Tegalsasri Coastal Fishing Port, encompassing various issues. These issues are grouped into biological, technological, and socio-economic aspects.

The Tegalsari Coastal Fishing Port serves as a landing base for fishing vessels that utilize a type of fishing gear called '*cantrang*.' The *cantrang* net has become the dominant fishing gear used at the Tegalsari Coastal Fishery Port, with approximately 90% of vessels utilizing this gear. However, fishing with *cantrang* is characterized by a lack of selectivity, leading to the capture of fish of various sizes and species, including immature fish that are not yet ready for harvest. The extensive use of cantrang has significantly contributed to the depletion of demersal fish stocks and changes in the composition of catch.

The study conducted by **Suwarso *et al*. (2020)** indicates that, in addition to a decline in number of catches, there has also been a significant change in the composition of the catch, particularly an increase in the percentage of squid. The proportion of squid in the total catch of *cantrang* landed at the Tegalsari coastal fishing port increased from approximately 6% in 2012 to 12% in 2015, then rose to 26% in 2016, before slightly decreasing to 20% in 2018 and to 18% in 2019. The types of fishing gear such as *cantrang/dogol* in Central Java, which are very effective in capturing demersal fish, are non-selective fishing devices because the *cantrang/dogol* in its pocket is a net made of plastic weaves, preventing small fish (juveniles) from escaping **(Suharno & Widayati, 2015; Subehi *et al.*, 2017)**. The continual increase in fishing efforts that have exceeded optimal capacity has resulted in a decline in productivity. This, in turn, leads to the depletion of local fisheries due to overfishing **(Ding *et al.*, 2017; Kristiana *et al.*, 2021; Bach *et al.*, 2022)**. The status of demersal fisheries in Tegal, particularly along the North Coast of Java, indicates concerning signs of overfishing and a decline in catch levels in recent years.

The increase in the number of fishing gear and fishing efforts at the Tegalsari coastal fishing port can be observed in Fig. (3). The rise in the number of fishing

gear and fishing efforts began in 2010 and continued to increase until 2015. The cantrang net has become the choice of fishermen at the Tegalsari Fisheries Port for catching demersal fish. This fishing gear is far more effective in capturing demersal fish compared to gillnets or other fishing tools **(Yulieny *et al*., 2019; Salsabila *et al*., 2021)**.

Fig. 3. The number of cantrang and the fishing efforts undertaken by fishermen at Tegalsari Fishing Port in Tegal Regency, Indonesia, over the period from 2008 to 2019

The intensive use of *cantrang* net in the northern waters of Java has resulted in a decline in the catches of *cantrang* landed at the Tegalsari coastal fishing port. A ban on the use of *cantrang* was enforced through the Minister of Marine Affairs and Fisheries Regulation Number 2 of 2015, which was eventually implemented on July 1st, 2017. The government once again legalized the use of cantrang through the Minister of Marine Affairs and Fisheries Regulation Number 59 of 2020. This decision was met with opposition from various parties as *cantrang* is considered an environmentally unfriendly fishing gear. Subsequently, the government reinstated the prohibition on the use of cantrang, dogol, pair seine, and similar fishing gear, through Ministerial Regulation Number 18 of 2021 (**Budiarti *et al*., 2024**).

The *cantrang* fishing units operate in the northern waters of Java, with fishing areas located between 4 and 5 degrees South latitude and 108 and 109 degrees East longitude. *Cantrang* fishing units with a size of less than 30 GT (Grosss Tonnage) conduct fishing operations with trip durations that range from 1 day to 1 week. The locations of the fishing areas for *cantrang* vessels with size less than 30 GT are illustrated in Fig. (4).

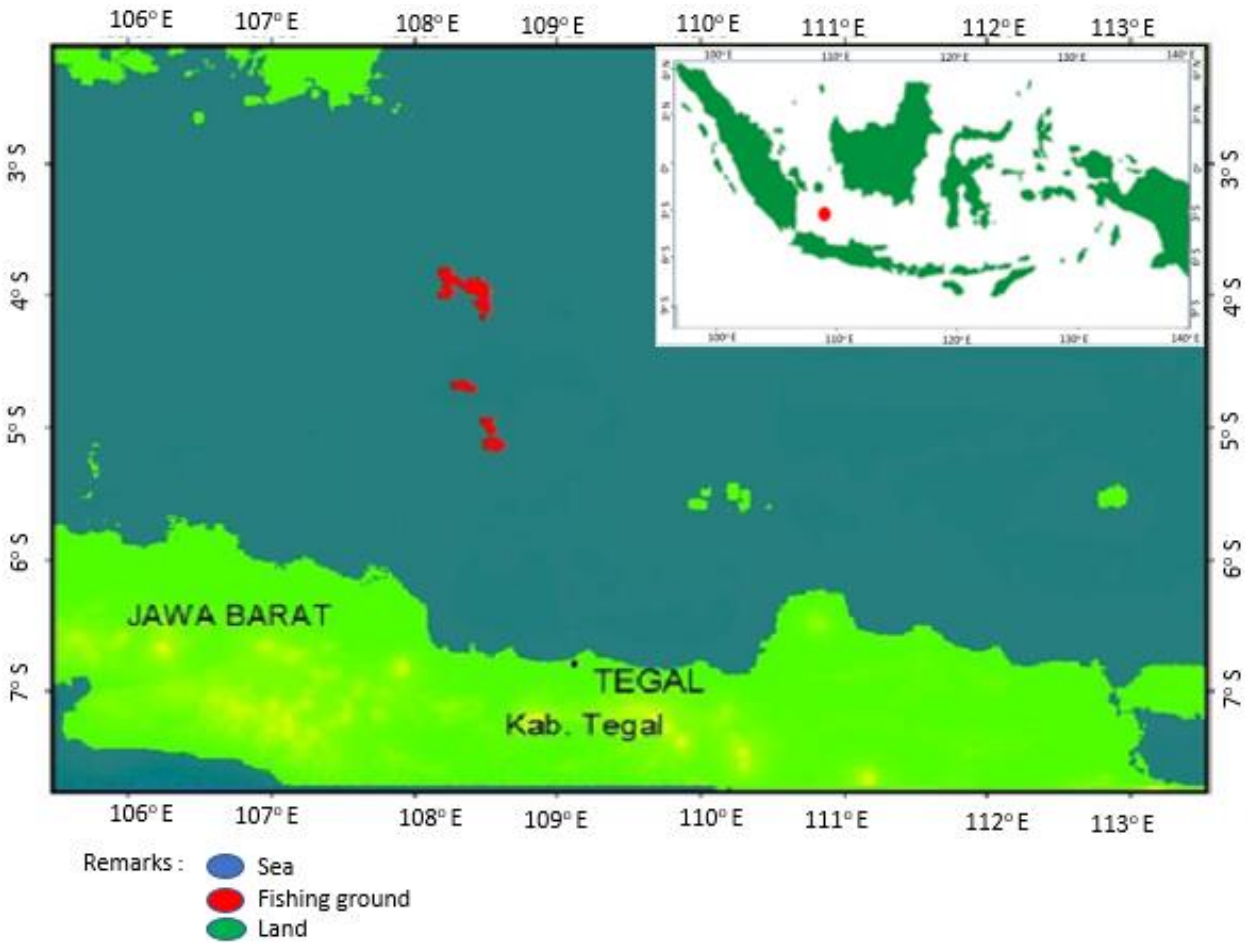

Fig. 4. Distribution of fishing grounds for *cantrang* fishing vessels with size less than 30 GT

Vessels larger than 30 GT dominate the cantrang fishing units docked at the Tegalsari Coastal Fishing Port in Tegal City. To maintain the quality of the catch, these vessels are generally equipped with cooling systems inside the hold. The straits in the southern part of Sumatra Island (the Estuary of Seputih River, the Estuary of Kambas River-Tanjung Sekopong, Maringgai, the Estuary of Sekampung River, and Mundu Beach) and the southern part of Kalimantan Island (Tanjung Selatan and Tanjung Putting) are fishing grounds for *cantrang* vessels that are over 30 GT, as illustrated in Fig. (5).

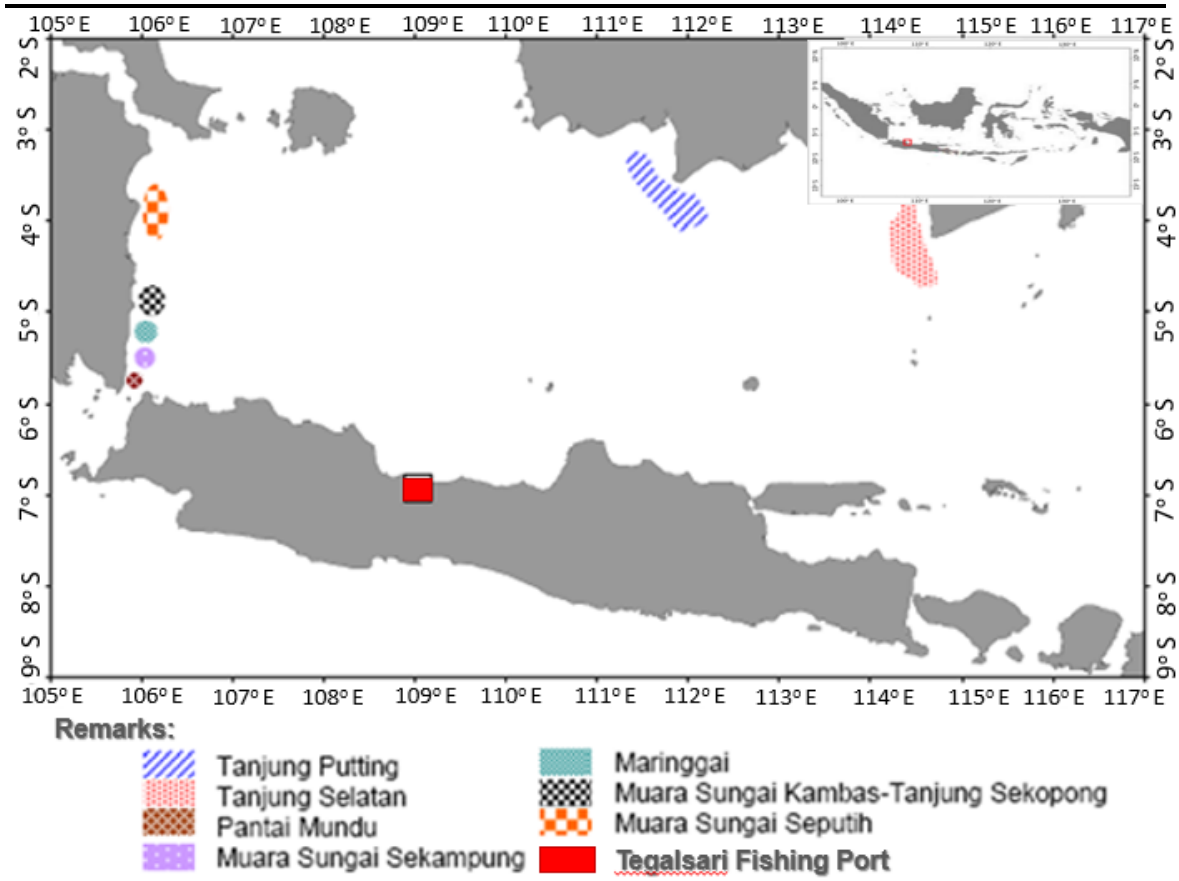

Fig. 5. Distribution of fishing grounds for cantrang fishing vessels with size larger than 30 GT

2. DPSIR framework analysis

The DPSIR structure adopted in this study is related to the use of fisheries resources based of the following factors:

2.1 Driving force

The driving factor is the potential of the fisheries economy, considering the sharp increase in the demand for fish and other marine products in the global market recently. The Organization for Economic Cooperation and Development (OECD) reported that in 2021, global fish consumption reached 180.07 million metric tons, an increase of 1.02% from the average consumption of 178.3 million metric tons between 2018 and 2020. Fish consumption in this region is projected to rise to 200.6 million metric tons of marine resources, particularly fisheries, by the year 2030.

Central Java Province is one of the regions that produces demersal fish in the northern waters of Java. The demand for marine fish in Tegal City is influenced by the level of community consumption, local fisheries production, and the distribution patterns of fish catches. The distribution pattern of marine fish catches in Tegal City is generally focused at the Tegalsari Fishery Port. From this port, the demersal fish is distributed to

local markets, such as the morning market and the rice market. Furthermore, fish are also sent to other regions, including major cities like Jakarta, Bandung, and Semarang, via both land and sea routes. This distribution process involves cooperation among fishermen, middlemen, wholesalers, retailers, and consumers. The high demand for fish protein-based surimi products used in various foods such as crab sticks and fish balls has led to an increase in demersal fish catches, as species such as small demersal fish (for example, lizardfish, goatfish, or flathead) are often used as raw material for surimi. Global surimi demand has risen alongside the increasing demand from the processed food industry, population growth, and a preference for seafood **(Budiarti *et al.*, 2024)**.

2.2 Pressure

The Java Sea has the potential for demersal fish catches which is estimated to reach 358,832 tons in 2022 with a utilization rate of 1.1. This indicates that the level of fish capture has reached overfishing status, as this condition has exceeded the Total Allowable Catch (TAC) which should be 80% **(Imron *et al.*, 2007; Kamal & Mehanna 2023)**. This situation creates pressure since it encourages more people to engage in fishing in the Java Sea, and the use of modern machinery and technology in vessels has made fishing more effective and rapid, exemplified by the increasing number of *cantrang* net. Advancements in the design and introduction of new technologies in the fishing fleet have significantly contributed to the increased efficiency of catches **(Hussein *et al.* 2021)**. However, these advancements have led to a declining trend in catch per unit effort (CPUE), which has reached a low point. Meanwhile, the resource base continues to diminish, as evidenced by ongoing and well-documented degradation **(Hosch *et al.*, 2021)**. This condition has resulted in a decline in the number of demersal fish resources in the northern waters of Java due to lax oversight from relevant authorities. Uncontrolled fishing practices driven by human activities are a significant factor contributing to the decline of marine biodiversity **(Shao, 2009)**.

The increasing demand for surimi materials can create several forms of pressure, both economically, environmentally, and socially. The pressures arising from this matter include:

- The pressure on marine resources such as overfishing and imbalances in marine ecosystems: Since surimi is typically made from small fish such as demersal fish; increased demand may lead to overexploitation of fish populations. Large-scale fishing can disrupt the food chain and the balance of marine ecosystems;
- The pressure on the fishing industry: This arises due to competition for raw materials and the need for technology and processing. The high demand for surimi raw materials can drive up the prices of raw fish, thereby making it difficult for small scale fisheries and other industry players that utilize the same type of fish. To meet market demands, the industry needs to invest in processing technology, cold storage, and logistics, which can burden small producers.

- The pressure on the environment stems from waste processing and carbon footprints. The surimi industry generates organic waste such as skins, bones, and wastewater that is high in protein. If not managed properly, this can lead to environmental pollution. The production and distribution processes of surimi, particularly when conducted on a large scale and involved in exports and imports, contribute to increased carbon emissions.
- Social and economic pressures, namely economic disparities, where large industries can dominate the market, making it difficult for traditional fishermen or small producers to compete leading to the dependence on exports; if the producing country is overly reliant on surimi exports, fluctuations in global prices and demand can affect local economic stability.

To meet the demand for surimi, the fishing industry must catch more demersal fish, which leads fishermen to rely on larger or additional fishing vessel fleets. This situation gives rise to IUU Fishing (Illegal, Unreported, Unregulated Fishing). To gain access to certain fishing areas, larger vessels are often manipulated; their size data are adjusted in such a way that they are categorized on paper as small or medium-sized boats, while in reality, they have a much larger catching capacity. This manipulation is performed to circumvent regulations and continue operating in areas that should be restricted to local fishermen/small boats.

The fishing pressure on demersal fish can be observed from the increase in demersal fish production at the Tegalsari Coastal Fishing Port as a result of the rising number of fishing efforts. Fig. (6) shows the increasing trend of demersal fish production during the period of 2008-2015. The fluctuations in catch results varied between 1,150 to 24,000 tons per year, with the highest catch recorded in 2013 (49,324.45 tons). Production declined during the period of 2016-2019, following the implementation of policies related to the prohibition of *cantrang* net.

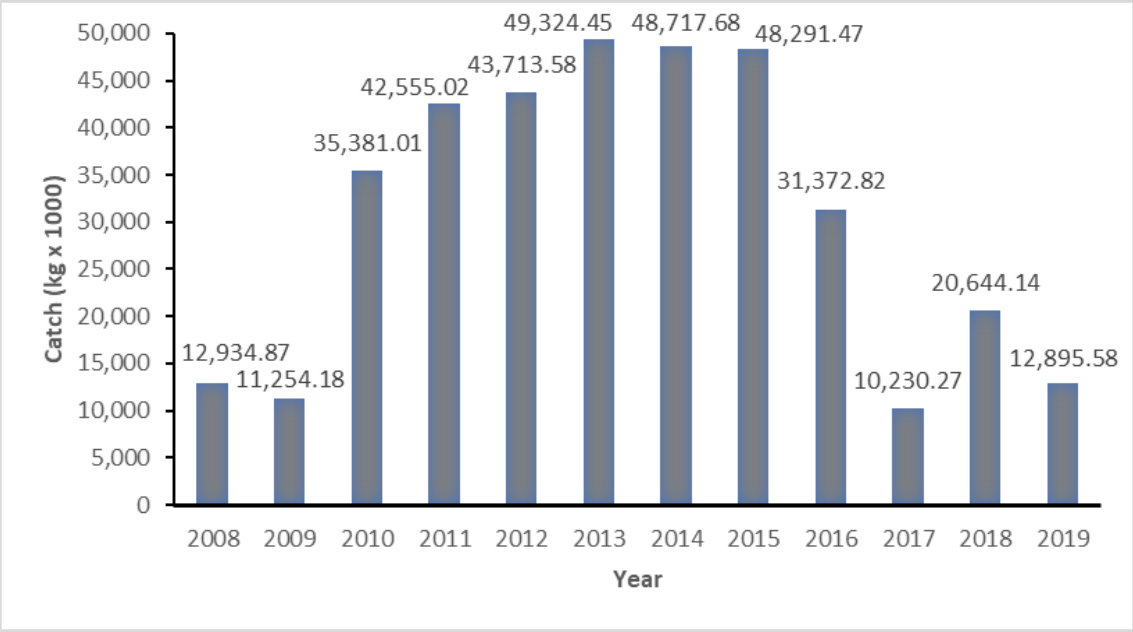

Fig. 6. The fluctuation of catch caught by *cantrang* landed at Tegalsari Fishing Port in Tegal Regency, Indonesia, during 2008-2019 (Source: Tegalsari Fishing Port data)

2.3 Impacts

The impact refers to changes in status resulting from shocks caused by human activities. These impacts include a decrease in the number of catches, bycatch/juvenile fish, and smaller sizes of captured fish, as well as ghost fishing leading to a drop in fish selling prices. This situation affects the socio-economic conditions of fishermen, including their income, which is also exacerbated by poor marketing systems, profit-sharing arrangements, and distribution systems. Therefore, the Indonesian government, through the Ministry of Marine Affairs and Fisheries (MMAF), has banned the use of *cantrang* net to preserve marine resources and ensure the sustainability of small-scale fishermen. **Sukandar *et al.* (2015)** state that the prohibition of fishing gear such as *cantrang* has resulted in a 30% reduction in the number of catches. However, neither of the two studies has revealed the full extent of the economic impact caused by the policy prohibiting the use of *cantrang*. Following the ban on *cantrang* and trawls, there have been impacts on unemployment, a decline in welfare, and an increase in criminality **(Ermawati & Zuliyati, 2015)**. The effects of the government policy that prohibits the use of *cantrang* net significantly influence the economic and social conditions of fishermen **(Sari & Brata, 2017; Hendrayana & Hartanti, 2018)**. The operation of *cantrang* net has a substantial impact on the economic and social conditions of fishermen (**Sari & Brata, 2017; Hendrayana & Hartanti, 2018**). To mitigate these adverse effects, it is important to consider measures such as sustainable fisheries management, the use of environmentally friendly fishing gear, and the diversification of surimi raw materials.

The impact on fish resources is evident from the drastic decline in catch per unit of effort in 2016 (Fig. 7), as a result of high effort levels during the period from 2010 to 2015 (Fig. 3). The ban on cantrang net has been effective in restoring fish stock. This is demonstrated in Fig. (7), where the value of catch per effort has increased again during the period from 2017 to 2019.

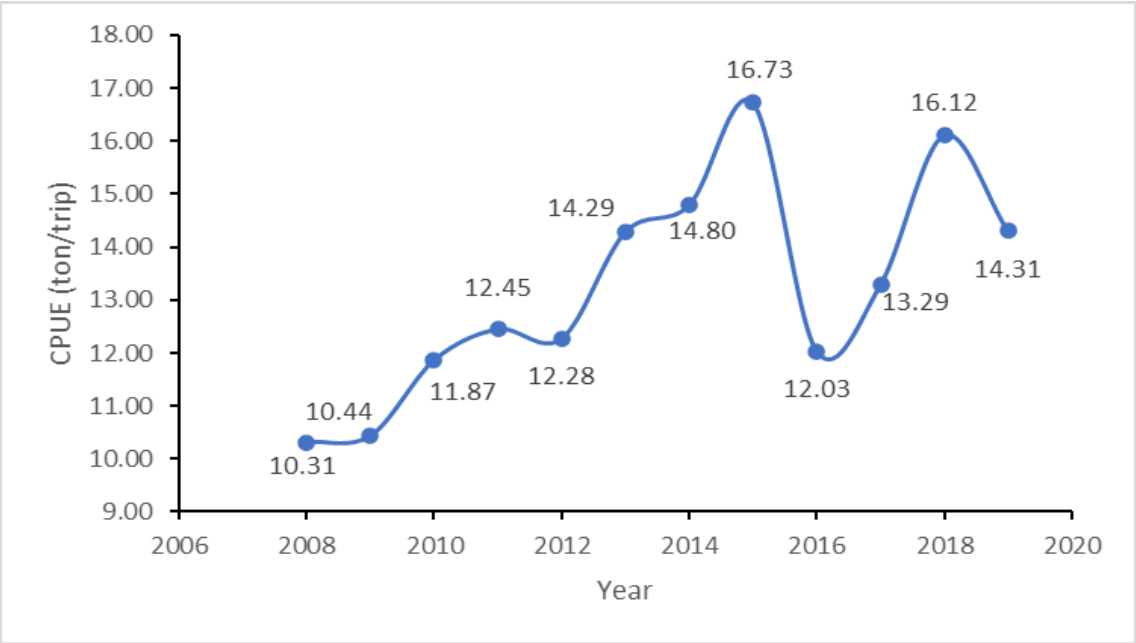

Fig. 7. Fluctuation in the catch per unit effort (CPUE) of *cantrang* in the Tegalsari Fishing Port area of Tegal Regency, Indonesia, from 2008 to 2019

2.4 Response

The response in question is a scientific response aimed at conserving fish resources and capture fisheries. To achieve sustainable capture fisheries objectives, breakthroughs related to input efficiency are necessary, particularly in terms of limiting the number of vessels and the size of fishing gear in operation. Weak control over inputs in capture fisheries is one of the main factors contributing to the decline in resource stocks, alongside environmental changes. An institution focused on regulating the number of capture inputs is also required. The Ministry of Marine Affairs and Fisheries has implemented Ministerial Regulation Number 18 of 2021, which prohibits the use of cantrang due to its detrimental impact on marine ecosystems. Although fishermen are encouraged to adopt pocketed pull nets as an alternative, the technical similarities between pocketed pull nets and *cantrang* raise questions. Regardless of the government's efforts to facilitate this transition, fishermen are grappling with significant challenges, including high costs of replacing fishing gear and existing debts. Many fishermen rely on *cantrang* as their main source of income, raising concerns about their livelihoods amidst these regulatory changes.

Therefore, the government has imposed a ban on the use of *cantrang* as part of its commitment to protect marine ecosystems, preferring instead to utilize pocketed pull nets, even though both fishing gear are relatively similar in operation. The main difference lies in the size and shape of the nets. Their sizes range from 1 inch to a minimum of 2 inches, and their shapes vary from diamond nets to square nets. This raises an important question: how effective are pocketed pull nets in mitigating the ecosystem damage that the government associates with fishing using *cantrang*? To answer this, a comprehensive evaluation is necessary to determine whether the change in net design has a significant impact. The name changes from *cantrang* to pocketed pull nets is accompanied by modifications to the net's construction. To understand the impact of these construction changes, a comprehensive evaluation encompassing technical and mechanical aspects is required. The government acknowledges the importance of conducting a thorough assessment of the social and economic impacts of the *cantrang* nets ban. Further research is necessary to ensure that the policies implemented do not adversely affect fishermen and continue to maintain the sustainability of marine resources. Ultimately, the government aims to achieve a balance between environmental preservation and the economic sustainability of fishing communities by enforcing the *cantrang* nets ban and advocating for the use of environmentally friendly fishing gear. This approach will be complemented by ongoing evaluations and policy adjustments based on real-world conditions **(Asnawi, 2022)**.

The DPSIR analysis effectively bridges the gap between large-scale human drivers of change in river estuaries and coastal areas, their impacts on these ecosystems, and appropriate management responses **(Mateus & Campuzano, 2008)**. Marine fisheries are generally conducted to obtain food resources from the seas and oceans, which is a key factor (D) in this framework. Fishing activities exert influence on marine ecosystems as a form of pressure (P). This pressure will result in a state (S) characterized by changes in ecosystem components, such as variations in fish abundance and distribution, as well as damage to the marine environment. These changes will affect (I) fish productivity and economic conditions. In response to the impact, various science-based management recommendations will be proposed and subsequently developed into concrete actions, such as the formulation of policies or legislation. **Indriadewi *et al.* (2023)** emphasize that the exploitation of the marine sector must be accompanied by strong and effective policies to regulate marine activities. This approach aims to mitigate environmental damage, particularly in marine areas, and to prevent the decline of fish populations and ecosystems. The DPSIR analysis of demersal fisheries in Tegal City has been prepared by considering the issues and problems that have developed as triggering factors. In addition, this analysis also formulates strategies as a response to the prevailing situation. In the realm of marine fisheries management, it is crucial to obtain technical support and important references regarding the impacts of various factors on fish catches. This information is essential for quantitative assessments and effective monitoring of fisheries, particularly fishing

capacity, as well as for efforts aimed at reducing, innovating, and converting fishing vessels **(Liu *et al*., 2021)**. The results of the DPSIR analysis can be seen in Fig. (8) and Table (1).

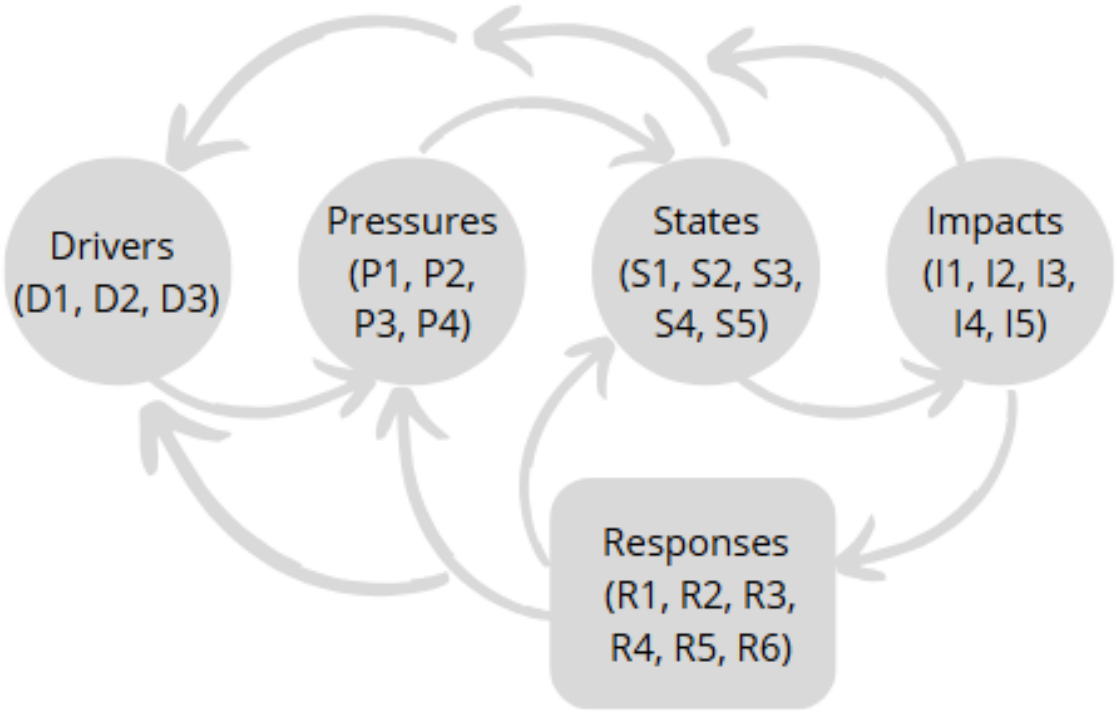

Fig. 8. Diagram of the results of DPSIR framework analysis

Table 1. The DPSIR framework analysis of demersal fisheries in Tegal City

Driving Force	• The high economic needs of coastal communities (D1) • The dependence of fishermen on cantrang fishing gear (D2) • The market demand for demersal fish and small fish (D3)
Pressures	• Overfishing due to the use of non-selective fishing gear (P1) • The damage of marine habitats due to the sweeping of cantrang nets (P2) • The catch that includes small fish (juveniles) and non-target species (P3). • Conflict over the utilization of marine space between traditional fishermen and cantrang fishermen (P4)
States	• The decline in the stocks of demersal fish and small fish (S1) • The degradation of marine habitat such as seagrass meadows and benthic ecosystems (S2) • The social tensions in the fishing community due to competition for fishing territories (S3) • Economic dependency on the cantrang fishing gear (S4) • The fisheries policy that has not been consistent or in favor of traditional fishermen (S5)

Impacts	• Decrease in income of traditional fishermen (I1) • Structural poverty in coastal communities (I2). • Horizontal conflict among fishermen (traditional vs cantrang) (I3) • Decline in marine biodiversity (I4) • Inefficiency in the management of fisheries resources sustainably (I5)
Responses	• Prohibition and restriction on the use of cantrang by the government (R1) • Convertion Program for fishing gear to environmentally-friendly seine nets (R2) • Improvement of supervision and control of fisheries (R3) • Involvement of the community and fishermen's organizations in monitoring and socialization (R4) • Strengthening local institutions and fishermen's cooperatives (R5) • Improvement of research and provision of fishery resource data for evidence-based policy making (R6)

CONCLUSION

The challenges associated with managing demersal fishery resources in the Java Sea need to be addressed, and one effective approach is the application of the DPSIR (Drivers–Pressures–State–Impact–Response) framework. The results of this study demonstrate that the DPSIR framework effectively reveals the interconnections between social, economic, and environmental components. The driving forces identified—such as increased fishing effort and dependency on *cantrang* gear—highlight the root causes of emerging problems, which subsequently contribute to environmental degradation in the demersal fisheries of the region.

This relationship is particularly evident through the depletion of fishery resources and the resulting decline in fish catches, which directly impact the livelihoods of local fishers. To mitigate these negative outcomes, it is essential to explore management measures such as the implementation of sustainable fisheries practices, the adoption of environmentally friendly fishing gear, and the enhancement of research and data collection to support evidence-based policymaking. For example, advancing research on the diversification of raw materials for surimi production may provide alternative solutions that reduce reliance on unsustainable fishing methods like *cantrang*.

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