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Mapping of Changes in the Utilization of Marine Resources in the Small-Scale Fisheries Subsector in Indonesia (2008-2017)

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ABSTRACT More than 80% of national fishery production is produced by small-scale fishers, who generally have low levels of education and live in small communities, making them vulnerable to global changes. Fishers in small-scale fisheries use simple technology to limit the search for target commodities and new land. Fishing technology and variability of fish commodities are spatial components that reflect the productivity of fish commodities. In this study, cluster analysis was used to identify shifts in the distribution of marine resource use in 2008-2017 in 34 provinces of Indonesia. By understanding the spatial distribution of small-scale fisheries, changes in coastal marine ecosystems can be identified to avoid overexploitation of marine products. The study results show that motorized and outboard motorboats have increased while non-motorized boats have decreased. Skipjack tuna, snapper fish, and crab commodities are a significant production volume. Clustering analysis resulted in three groups with different characteristics. Cluster 3, which consists of Banten, West Java, and North Sumatra, experienced significantly increased fisheries productivity. Therefore, a priority scale program is needed by growing small-scale fisheries' role, such as budget allocations, to improve the economic scale of business actors in these areas.

Keywords: Clustering; utilization; marine resources; small scale fishery

INTRODUCTION

More than 90% of the world's captured fisheries workers work in small-scale fisheries (Crona *et al*., 2016). It is estimated that 97% of small-scale fishers are found in developing countries (Langdon, 2015), such as Indonesia. According to the Ministry of Maritime Affairs and Fisheries (KKP), In 2017, around 15 million workers were directly involved in the fisheries sub-sector in Indonesia, which collectively produced 23 million tons of fish and contributed 2.57% to GDP (MMAF, 2018). Until now, most of the fishery production still comes from marine fisheries. The potential of Indonesia's marine resources in the fisheries sector is still quite significant. However, this does not mean that the 5 be met. This causes the level of utilization to be uneven between regions. Most fishing activities still revolve around coastal waters concentrated in densely populated areas. Even in certain waters, such as the north coast of Java and the Malacca Strait, the utilization rate has exceeded the available potential (Dwiponggo, 1991).

Small-scale fisheries still dominate most of Indonesia's fisheries production, and the industrial sector is estimated to harvest half of fish production and account for 80% of the fishing sector (Kusdiantoro *et al*., 2019). In defining small-scale capture fisheries actors, according to Law number 7 of 2016 concerning the protection and empowerment of fishers, fish cultivators, and salt farmers, small-scale fishers are who catch fish to fulfil their daily needs, both those who do not use fishing vessels or those who use ships with a maximum size of 10 GT This type of fishery is profitable and vital in ensuring food security, nutrition, and livelihoods (FAO, 2015).

Workers directly involved in small-scale fisheries generally have low levels of education, live in small communities, are often isolated from economic centres, and are not well organized politically (Damasio *et al*., 2020). The view that small-scale fisheries have less contribution than industrial-scale fisheries has increasingly led to neglect of small-scale fisheries so that fishers are vulnerable to local and global changes (FAO, 2019).

Small-scale fisheries management is currently seen as still not optimal. As a fishery manager, the government does not consider local characteristics in each region in carrying out fisherman capacity development activities (Espinosa-Romero *et al*., 2014). As we know, fishing communities already have their fishing activity management system, although it is still traditional. Nevertheless, at least the system has been running so far. In addition, one of the problems that are often overlooked in the small-scale capture fisheries development approach is the different characteristics in each region. Lack of information about the landscape of small-scale capture fisheries in each area can make government interventions in development programs ineffective.

In addition, the level of resource utilization between regions is still uneven. This condition is closely related to the technology used, resource management, and fishers' skills. Bailey stated that one of the most critical problems Indonesian fisheries face is managing fisheries resources (Bailey, 1992). The nature of fishery resources which are common property rights is the primary source of managing these resources. Smith suspects that to some extent, in some countries, government policy to permit larger-scale fishing companies to operate in fishing has contributed to conflict between fishermen (Smith, 1979). Damage to marine ecosystems due to exploitation is also one of the problems that cause the collapse of target commodities and result in food insecurity and loss of income sources (Carter *et al*., 2018).

Since Pelita I, the government has implemented many programs to improve the condition of people's fisheries, such as introducing technology and constructing fishery facilities in production centres. Recently there has also been cooperation between small fishers and BUMN/private parties engaged in the fishery sector. Collaboration is not only in the field of production but also in marketing. Although the condition of fisheries, in general, is still traditional, the role of this sub-sector in the regional economy is quite important.

The condition of small-scale capture fisheries in each region has unique and different characteristics (Guyader *et al*., 2013). These characteristics can be in the form of their response to natural conditions, the attitudes and behaviour of the fishers concerned, ownership of the fleet and fishing gear, the ability to manage finances, the social structure formed in the fishing community, and the existing institutions in their area. The diversity of characteristics of small-scale fisheries becomes very difficult to regulate centrally (García Lozano & Heinen, 2016). These very dynamic small-scale capture fisheries activities need to be clustered based on their similar characteristics. The similarity of these characteristics can be viewed from the aspects of sustainable fisheries development (Carles *et al*., 2014).

One aspect of sustainable fisheries development is technology, both in fleets and fishing gear. One of the functions of this technology is to assist fishers in determining the location of fish catches (Prihandoko *et al*., 2011). Small-scale fishers generally use small boats with simple technology, often without adequate means to ensure their safety while at sea (Ermayanti, 2015). That usage limits the search for new target commodities or land. Another factor is the distribution of target commodities and the technical resources available to reach fishing grounds safely (Daw, 2018). These factors result in a spatial mapping in terms of fishing and business.

Spatial mapping of changes in the use of marine resources can identify trends in the distribution and plenty of fish to build marine conservation areas. The spatial component reflects where the productivity of the commodity is highest. By understanding the spatial distribution map of changes in the use of marine resources in small-scale fisheries based on the factors that drive this distribution, coastal marine ecosystems can be identified to avoid overexploitation of marine products. This study aims to determine whether small-scale fisheries experienced a shift in spatial distribution between 2008 and 2017 in 34 Indonesian provinces. The factors used to identify are changes in commodity targets and fishing technology.

MATERIALS AND METHODS

Materials

Table 1. Types and sources of research data.

Variable	Data Type/Scale	Sources
Fishery main commodity	Numeric/Ratio	Ministry of marine and fisheries
Boat type	Numeric/Ratio	Central bureau of statistics
Fishery production volume	Numeric/Ratio	Central bureau of statistics

This study uses secondary data in the form of time series in 2008-2017 with provinces in Indonesia as objects. The selection of 2008 and 2017 as breaking points was based on limited data on each variable. However, ten years is considered sufficient to detect changes and provide reasonably good information with a minor standard deviation.

In addition to simple boat/ship technology, this study uses ten primary fishery commodities: skipjack, snapper, mackerel, kite, crab, mackerel, anchovies, tuna, and shrimp factors calculating the spatial distribution in 34 provinces in Indonesia. Another factor used is the volume of national capture fisheries production. Details of data types and sources are shown in Table 1.

Methods

In this article, data processing techniques to identify the spatial distribution of the development of marine space use in Indonesia from 2008 to 2017 use several analyzes with the following details.

GGPlot

ggplot is one of the functions in Rstudio software that can be used to present data in various forms, such as diagrams, scatterplots, histograms, and others (Gio & Effendi, 2017). In this study, data analysis was carried out using the ggplot algorithm in Rstudio to provide visualization and interpretation of data on changes in the use of marine resources in terms of boat/ship use and the production of 10 fishery commodities. This analysis will provide an overview and pattern of 2008 to 2017 throughout Indonesia.

Wilcoxon test

Test the significance of changes in fishing activity using the Wilcoxon test because the data is a ratio scale. The Wilcoxon signed-rank test is a non-parametric statistical hypothesis used to compare two related samples, matched samples, or repeated measurements on one sample to assess whether their populations exhibit different ratings (Anaene-Oyeka & Ebuh, 2012). The Wilcoxon signed-rank test can help determine whether two dependent samples are selected from a population with the same distribution. The significance test in this study was carried out to see the pattern of changes at sea in terms of ship use and fishery commodity production. This test is done to know the significance of changes in the use of boats/ships in what type and which fishery commodity is the highest. So will be obtained variables that experience significant changes.

K-means Clustering

Clustering analysis is used to determine the spatial distribution of changes in fishing activity in Indonesia. In this article, the researcher uses the k-means clustering algorithm, a cluster analysis method that groups each observation where the practitioner determines the number of clusters. K is used to divide objects in each cluster with almost the same characteristics (Zhang & Fang, 2013). So that in this study, the use of k-means clustering will provide a mapping category for regions or provinces in Indonesia that are changing. This category or clustering is divided into 3 clusters. A first cluster is a group with minimal changes in the production of fishery commodities and the use of boats/ships, in the sense that the conditions are relatively the same or even decreased from 2008 to 2017.

Visualization of clustering results on a map of Indonesia using ArcGIS software. This software makes it easy for researchers to create mappings (including adding attributes and legends). ArcGIS has various tools to create, manage, analyze, map, and share spatial data (Docan, 2016). This technique is carried out to provide a visual description through a map of Indonesia that can show the provinces or regions experiencing changes in the use of marine resources. This visualization also provides an overview of the mapping of provinces in Indonesia that are included in the 3 clusters of change above.

RESULTS AND DISCUSSION

The characteristics of small-scale fisheries

The type of boat/ship used by fishers is one of the variables in identifying the spatial distribution of changes in fishers' fishing activities. Figure 1 shows that the pattern of using outboard motorboats and motorboats is almost the same. Using a non-motorized boat is the opposite of the pattern of the other two types of boats/ships. In 2008, non-motorized boats dominated the fishing technology most widely used by fishermen (401.67 thousand), followed by the use of outboard motorboats (223.26 thousand) and motorboats (163.92 thousand). In 2014, this condition reversed; non-motorized boats and outboard motorboats decreased, while motorized boats increased.

The year 2016 was the highest point for the use of outboard motorboats with an increase of 39.21% from 2008, but this year became the lowest point for non-motorized boats, which decreased by 30.69% from 2008 (Figure 1). In the same year, the use of motorized boats also reduced from the previous year by 21.58%. The use of motorized boats in 2017 has decreased, while the use of outboard motorboats and non-motorized boats has reversed. The use of non-motorized boats by fishers increased by 9.8% from the previous year. The use of outboard motorboats experienced a sharp decline of 21.16%.

According to the Secretary-General of the Indonesian Tuna Association (ASTUIN), the decline in the number of vessels was the cause of the low production of capture fisheries in 2016 (Kontan, 2017). It was explained that based on data published by the Ministry of Maritime Affairs and Fisheries (KKP), the number of fishing vessels that were no longer operating during 2014–2016 was 128.495 units. The decrease in the number of fishing boats is not comparable with the presence of new fishing vessels assisted by the KKP, which amounted to 1.959 units. Therefore, ASTUIN assesses that the assistance of the KKP ship will not significantly affect the increase in domestic capture fishery production. The availability of vessels determines the productivity level of capture fisheries.

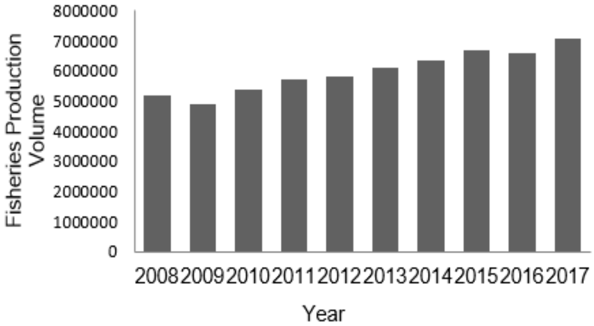

Figure 2. Development of small-scale fishery production volume in 2008-2017.

Another factor in identifying the spatial distribution of developments in marine resources is the volume of fishery production. Figure 2 shows a positive trend in national fisheries production patterns from 2008 to 2017. The volume of fishery production in 2017 increased by 1,875 thousand tons (36.09%) from 2008. In 2009 and 2016, production volume decreased by 5.42% and 1.46%, respectively. Based on Food Outlook data, capture fisheries production in Indonesia decreased by 4.55% in that year. This is because fish resources around Indonesian waters, especially the Indian and the Pacific oceans, show a fully exploited condition (FAO, 2010).

The main commodity can break down the volume of fishery production to see changes in fishing patterns in determining fish catch targets, as visualized in Figure 3. In general, nine central fisheries commodities experienced an increase in production volume nationally from 2008 to 2017, except for mackerel scad production, which decreased by 1.81 thousand tons (0.55%). Some of the commodities with the highest percentage increase in production volume were crab with a production difference of 233.58 thousand tons (601.43%), snapper fish with a production difference of 332.96 thousand tons (178.90%), and Spanish mackerel with a production difference of 173.71 thousand tons (136.79%). Other fishery commodities such as skipjack tuna, mackerel fish, anchovy, mackerel tuna, tuna, and shrimp experienced a 38-87% increase in production in 2017

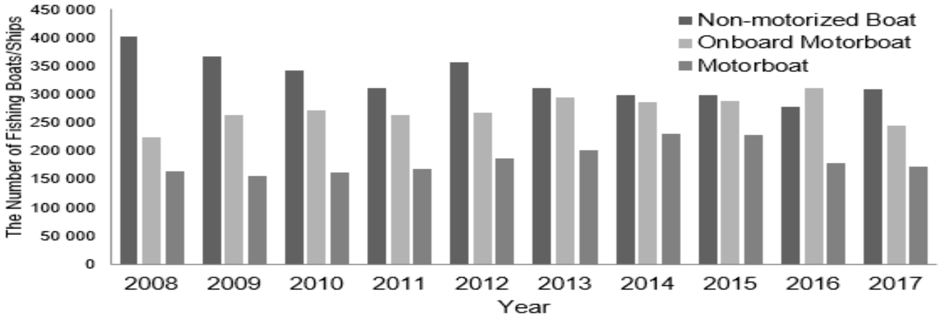

Figure 1. Development of ships/fishing boats in small-scale fisheries in 2008-2017.

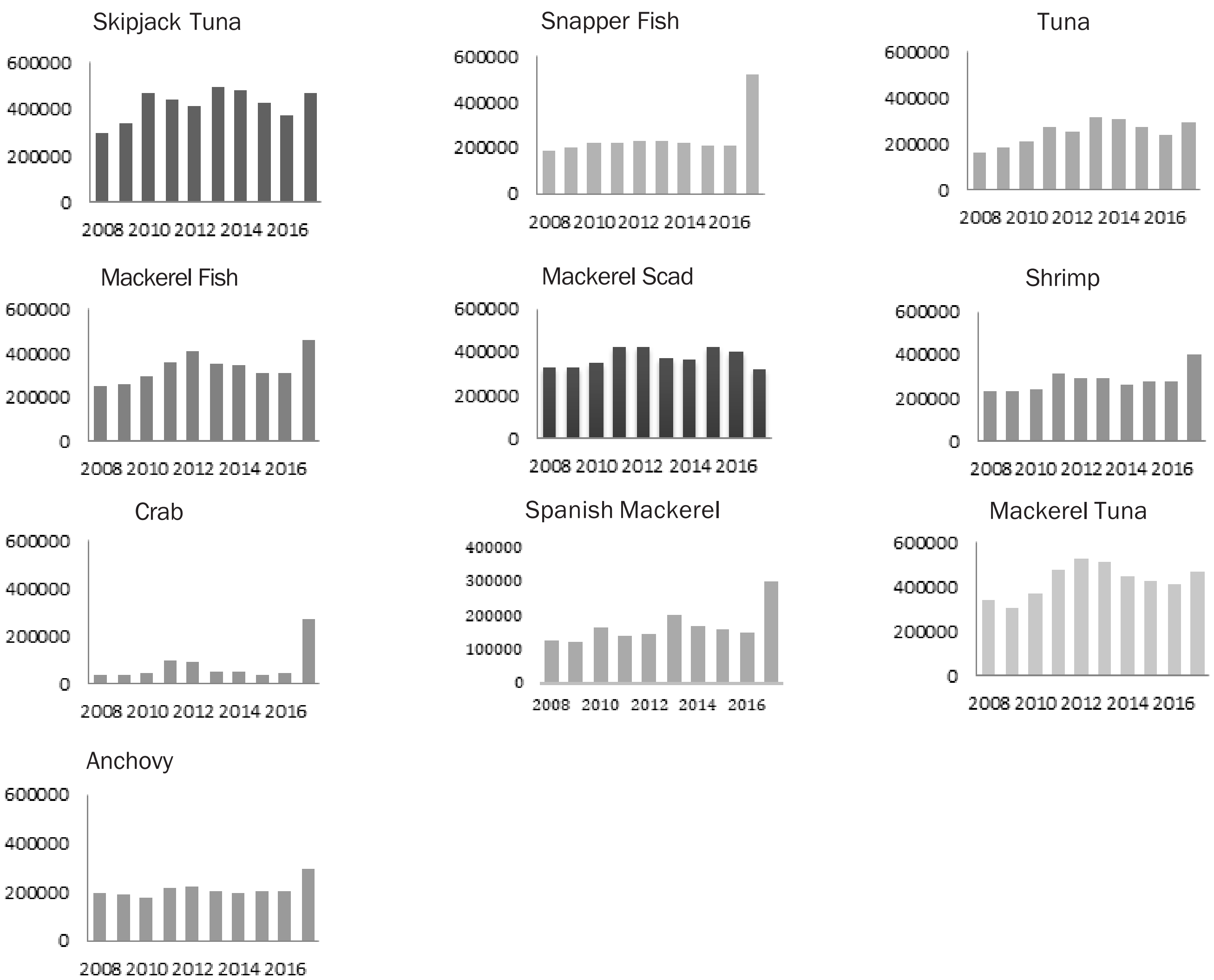

Figure 3. Production development of 10 primary small-scale fishery commodities 2008-2017.

Table 2. Wilcoxon test of boat type variables and fish commodities.

Variables	2008		2017		Wilcoxon Test	
	Mean	Standard deviation	Mean	Standard deviation	Value	P-value
Boat Types						
Non-motorized Boat	11.814	11.422	9.079	9.678	212.0	0.929
Outboard Motorboat	6.566	7.480	7.207	6.949	394.0	0.050*
Motorboat	4.821	5.372	5.096	4.873	332.0	0.281
Fish Commodities						
Skipjack Tuna	9.704	14.714	13.751	19.333	278.0	0.045*
Snapper Fish	6.515	10.967	14.618	22.550	436.0	0.009*
Mackerel Fish	8.644	8.873	13.055	17.930	317.0	0.260
Mackerel Scad	10.330	14.453	9.575	16.503	214.0	0.751
Crab	1.265	2.107	7.935	20.787	279.0	0.094*
Spanish Mackerel	4.830	4.676	7.410	20.535	226.0	0.891
Anchovy	5.208	6.504	8.647	17.928	286.0	0.464
Mackerel Tuna	10.791	8.453	13.853	16.591	294.0	0.527
Tuna	6.288	9.312	8.745	14.826	229.0	0.171
Shrimp	7.092	7.840	13.269	27.511	344.0	0.130

*Significant at α (alpha) = 0.1

If seen in Figure 3, the commodities caught by fishers in 2008 and 2017 are almost the same. In 2008, the five primary commodities with the highest production volumes were mackerel tuna (342.25 thousand tons), mackerel scad (327.37 thousand tons), skipjack tuna (296.77 thousand tons), mackerel fish (249.44 thousand tons), and shrimp (236.92 thousand tons). In 2017, mackerel tuna (471 thousand tons), skipjack tuna (467.55 thousand tons), mackerel fish(465.16 thousand tons), and shrimp (400.07 thousand tons) still ranked in the top 5 commodities with the highest production volume. Mackerel tuna and skipjack tuna are a group of large pelagic fish which, according to the Food Agriculture Organization (FAO), are one of the great potentials of capture fisheries in Indonesia (Kusdiantoro *et al.*, 2019), so their production almost always increases every year. Meanwhile, mackerel scad production decreased and was replaced with snapper fish, ranked the first commodity with the highest production volume of 519.07 thousand tons.

Analysis of the significance of changes in patterns of fishing activities

If in the previous sub-chapter the pattern of changes in fishing activity was known based on the variable type of boat/ship and production volume on ten primary commodities, then in this sub-chapter, a significance test was conducted to find out whether the changes were significant to the spatial distribution pattern of the development of marine resource utilization.

Table 2. provides information that the significant category for the boat type variable is outboard motorboat with a significance value of 0.05. This shows a significant increase in outboard motorboats from 2008 to 2017, with an average increase from 6.566 to 7.207 outboard motorboats. In addition to outboard motorboats, motorboats also experienced an average increase of around 5%, although this increase was not significant. It is different with non-motorized boats, which decreased by an average of almost 23% from 2008. The use of more extensive fishing technology (vessels/tools) may respond to the decline in catch caused by local exploitation of fish, competition with industrial fisheries, and coastal degradation (Pauly *et al.*, 2002). In addition, the increase in the use of motorized boats is a consequence of the idea that larger vessels/equipment will always produce more catches and of better quality (Wicaksono & Effendi, 2019) regardless of the sustainability of natural resources.

As for the fish commodity variable, the categories with a significant increase from 2008 to 2017 were skipjack tuna, snapper fish, and crab, with a significance value of 0.045, 0.009, and 0.094, respectively. The production volume of other commodities such as mackerel fish, Spanish mackerel, anchovy, mackerel tuna, and shrimp has increased within ten years, but according to the Wilcoxon test in Table 2, the increase is not significant. The only fish commodity that experienced decreased production volume in 2017 was mackerel scad (7%).

Spatial analysis of marine space utilization

Clustering marine space in this study uses the K-means method with three clusters. Cluster 1 is a group with minimal changes in the production of fishery commodities and the use of boats/ships, in the sense that the conditions are relatively the same or even decreased from 2008 to 2017. Based on Table 3, the first cluster has the highest number of members, as many as 20 provinces with a distribution as shown in Figure 4.

Cluster 2 is a group with significant changes in increasing production of fishery commodities and the use of boats/ships. The members of this cluster are 11 provinces (Table 3) with the distribution as shown in Figure 4. These provinces experienced an increase in production of snapper fish (0.3-11.6 times), anchovy (0.1-4.8 times fold), tuna (0.6-20.8 times), and shrimp (0.4-15.3 times) from 2008-2017. In terms of the use of boats/ships, members of this cluster experienced an increase in the use of motorboats 0.17-4.44 times, non-motorized boats 0.28-1.75 times, and outboard

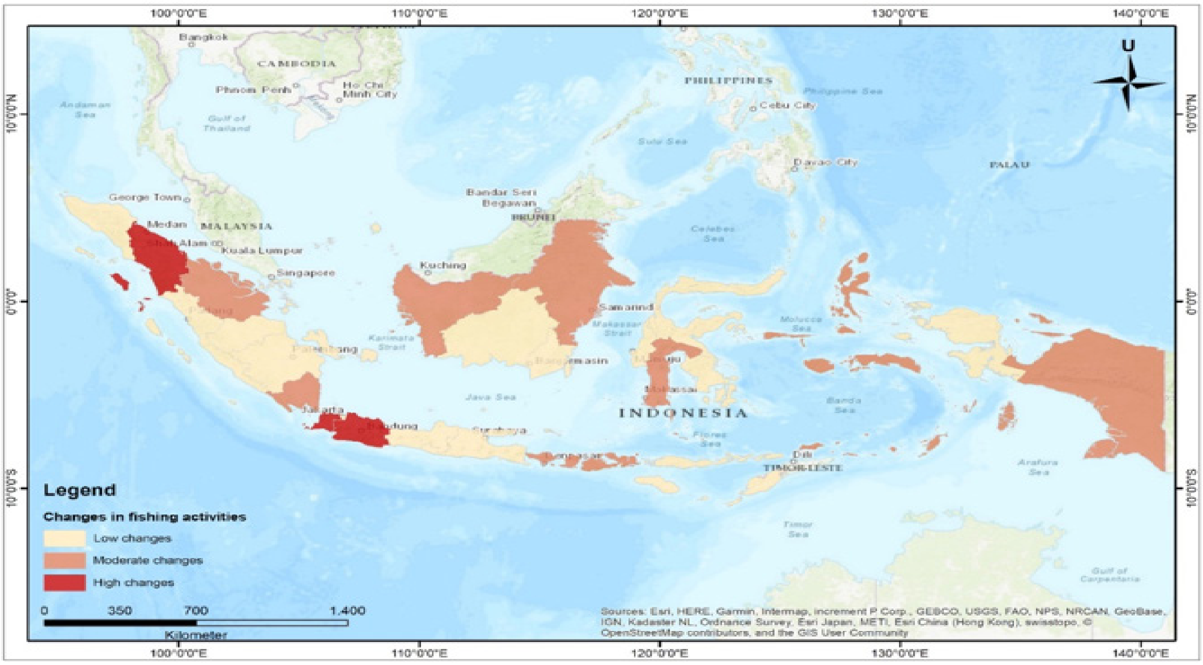

Figure 4. Clustering the development of small-scale fishery marine space use.

motorboats 0.45-3.38 doubled from 2008-2017.

Table 3. Summary of cluster analysis of marine space use.

Cluster	Number of observation	Sum of square	Average distance from centroid	Maximum distance from centroid
Cluster1	20	137.262	2.328	5.364
Cluster2	11	167.359	3.463	8.048
Cluster3	3	59.778	4.368	5.321

Cluster 3 is a group that has experienced significant changes in increasing the production of fishery commodities and the use of ships/boats. This cluster consists of 3 provinces (Table 3), namely Banten, West Java, and North Sumatra (Figure 4). Banten is the province with the highest volume of mackerel fish production in Indonesia, which was 55 thousand tons of fish in 2017 (MMAF, 2018). This figure has increased ten times from the production of mackerel fish which in 2008 was only 5 thousand tons. West Java is also the province with the highest production of crab fish commodity in Indonesia in 2017 (MMAF, 2018), with a total production of 111 thousand tons or 17 times the production in 2008.

Meanwhile, North Sumatra is a province with increased production in almost all major commodities. Especially in shrimp commodities with 158 thousand tons, anchovy 89 thousand tons, and mackerel fish 81 thousand tons in 2017 (MMAF, 2018). Respectively, this commodity experienced an increase in production of 1.07, 3.23, and 2.56 times from 2008. In terms of boat/ship usage, members of this cluster experienced an increase in motorized boats from 1.3 to 4.7 times, non-motorized boats 0.6-4.1 times, and outboard motorboats 0.4-1.48 times.

According to Law No. 45 of 2009, fishers in small-scale are categorized by the ownership of fishing vessels with a maximum size of 5 grosstonase (GT) (RI, 2009). The Department of Fisheries and Marine Affairs classifies fishers in this sub-sector according to the ownership of outboard motorboats, non-motorized boats, and motorboats for modern fishers (Rahim, 2016). The fishing sector is diverse along the 8600 km coastline, and its characteristics vary according to the region, ranging from fishing around the bay to long distances in the high seas (Vatria *et al*., 2019).

The increase in the use of motorboats in small-scale fisheries, as shown in Figure 1, shows that the modernization of fisheries makes a significant contribution to the increase in production factors. However, modernization also causes the social formation of fishing communities to change gradually (Satria, 2001). This change is manifested by adapting the capitalist mode of production, which eliminates the traditional production method. In facing the modernization of fisheries, there are at least three strategies that fishers must choose, namely: adaptation strategy, survival strategy, and escape strategy. In response to the demands of today's fisheries, small fishers generally choose adaptation strategies. This strategy brings more significant opportunities for them to experience vertical mobility (upward mobility).

Modification of the shape and size of the boat, which has been equipped with an engine as a driving force, is generally operated farther out to sea. This modified boat is generally used for fishing activities through more extensive net technology. The motor as the propulsion of the boat, replacing the sail component, can be adapted to all types and types of traditional boats, ranging from the Koli-Koli, trunk body, and Selangka (small size boats), sope (medium size boats), as well as Boti and Lambo (large boat) which is modified into a motor sailboat (PLM).

The adoption of new technologies and patterns in fishery activities of this scale has begun to emphasize effectiveness. Initially, the motorization of fishing boats (fleet), in the form of motors with a power of 4.5-10 PK, was only adopted by a few fishermen. They are generally the owners of traditional fishery production tools. This is in response to modernization development in the late 1980s; most fishers have used this type of motor to support fishing operations.

The use of outboard motorboats has supported fishers' businesses with small-scale nets. Through motors in these boats, fishers can achieve surplus production. Furthermore, entering the 1990s, a small number of fishing boats have been adapted to motorboats with a power of 10-30 HP Except for the trunk body boat, which is relatively large, the type of sope boat which has undergone modifications in shape and size, in relatively small quantities, has been equipped with this type of motor technology innovation (Munafi & Tenri, 2016).

In 2017, the pattern of using the type of boat/ship was the same as in 2008, meaning there is not much change in the pattern of fishers' activities using fishing technology. This provides an overview and hypothesis regarding the increasing cost of production in small-scale fisheries and uncertain environmental conditions and fishery resources. For example, the expansion of large fishing vessels makes small-scale fisheries increasingly marginalized and access to fish resources more complex, thus reducing the use of motorboats. Small fishers prefer to use boats without motors and outboard motorboats, which allow them to keep fishing at a low cost. It also shows that the large capacity of ships/boats will only cover or delay economic losses because there are other unforeseen factors such as climate, biological oceanography, fish ecology, and various social and economic factors, such as alternative livelihoods and demand. A market that can affect fish production by fishers (Sethi *et al*., 2012).

According to KKP data, snapper production in 2017 was 25.051 tons, a significant increase from the previous year's production figure of only 5.544 tons. Of the total production of snappers, 90% of them are white snappers. Meanwhile, in terms of value, the production of snapper fish in 2016 has reached Rp 380 billion and then increased to Rp 1.7 trillion in 2017. In 2016, 78% of national snapper production came from East Java 1.602 tons, East Kalimantan 1.435 tons, and Riau Islands 1.292 tons. White snapper is one of the leading fishery commodities prioritized by KKP for export. The domestic absorption rate has increased and shows a good business climate, in addition to reasonable selling prices.

On the other hand, the production of scad fluctuates. Fluctuations in the productivity of scad caught in Figure 3 can be explained that the volume of productivity is influenced by the amount of fishing effort made. The higher the fishing effort (trip), the higher the production volume. Productivity in 2007 was 2.60 tons/trip. In 2008 it began to decline until 2012. The productivity of scad fish increased again in 2013. This condition can be said that scad fish recruits in fishing areas within 5-6 years. A decrease influenced the decrease in productivity in production volume, where fishing activity was more remarkable than recruiting scad stock in fishing areas in that year (Mahmud & Bubun, 2015).

According to the Wilcoxon test results, changes in the volume of fishery production in some commodities are not significant. One of the causes of the decrease and insignificant increase in fish production is the enactment of several government policies related to fishing, such as the prohibition of the use of Cantrang according to the Minister of Agriculture Regulation No. 2 of 2015 (MMAF, 2015). This regulation is one of the efforts to preserve fishery resources because it is considered a fishing tool that is not environmentally friendly and contributes significantly to destroying marine habitats and affecting the life cycle of marine biota (Arafat & Khairi, 2018). Another thing is the attitude of fishermen who do not take action to find out their catch and economic activities (Prihandoko *et al*., 2011).

Fishing technology and volume of fishery production in some of these resources produce a distribution map of marine resource utilization as shown in Figure 4 with a total of 3 clusters. The results of this grouping show how small-scale fisheries, primarily practised at the local level, have developed geographically over the past ten years to explore areas further from the coast (high seas). Geographical expansion by small-scale fishers is most likely a strategy to continue maintaining fish income after the area closest to the coast is depleted due to overfishing (exploitation) or habitat degradation. The farther from the coast, the less productivity of the land, especially pelagic species that the fishing industry can only reach by large vessels (Damasio *et al*., 2020). Spatial variation in fishing is also one strategy to reduce the variability of fishers' income, which is on the extraction of natural resources (Anderson *et al*., 2017).

CONCLUSION AND RECOMMENDATION

Conclusion

Small-scale fisheries' statistical problems related to recording catches are included in the primary input, leading to inefficiency in small-scale fishers' output performance, such as ship maintenance expenses, fishing gear repairs or purchasing expenses, and labour costs. Small-scale capture fisheries and non-commercial fisheries, particularly near shore, have been recognized as the basis for social, cultural, and food security reasons, but catches are rarely taken into account in official statistics, and their contribution is often not considered.

The development of the fishery sector is directed at increasing its role in creating strong linkages with other sectors, both forward and backward linkages, through increased value-added, employment, and increased income. This is expected to grow the economy through a multiplier effect, both direct and indirect impacts and side effects. So that in exploiting the potential of existing fisheries resources, mapping and clustering needs to be carried out as presented in the discussion.

Recommendation

The clustering results show that several regions have experienced changes and shifts in spatial distribution, especially in provinces with clusters 2 and 3. Various changes and shifts experienced by several regions are needed. Government support (Central and Regional) to increase the role of small-scale fisheries through program priority scales/ assistance, such as in budget allocations (Ship assistance program and KUR) to facilitate and provide certainty in access to inputs. In the form of capital credit and ships as a cheap source of a financing scheme, KUR is one of the crucial instruments to increase the economic scale of business actors in areas with significant spatial changes.

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AUTHOR'S CONTRIBUTIONS

We declare that each author's contribution to this journal article has equal weight so that the two authors, on behalf of Yulinda Nurul Aini and Fuat Edi Kurniawan, are the main contributors.

REFERENCES

Anaene-Oyeka, I.C & G.U. Ebuh. 2012. Modified wilcoxon signed-rank test. Open Journal of Statistics. 2 (2): 172-176. https://doi.org/10.4236/ojs.2012.22019.

Anderson, S.C., E.J. Ward, A.O. Shelton, MD. Adkison, A.H. Beaudreau, R.E, Brenner, A.C. Haynie, J.C. Shriver, J.T. Watson & B.C. Williams. 2017. Benefits and risks of diversification for individual fishers. Proceedings of the National Academy of Sciences of the United States of America. 114(40): 10797-10802. https://doi.org/10.1073/pnas. 1702506114.

Arafat, Y & M. Khairi. 2018. Kebijakan larangan penggunaan alat penangkapan ikan cantrang dalam perspektif negara hukum kesejahteraan. Borneo Law Review Journal. 2 (2): 141-159. https://doi.org/10.35334/BOLREV.V2I2.724.

Bailey, C. 1992. Meeting the Needs of Small Scale Fisheries Employment. Directorate General of Fisheries and AARD in Cooperation with USAID.

Carles, W.E.S., S.H. Wisudo & D.A. Soeboer. 2014 Characteristics of capture fisheries in Simeulue Districts sea waters area. Marine Fisheries. Journal of Marine Fisheries Technology and Management. 5 (1): 91-99. https://doi.org/10.29244/jmf. 5.1.91-99

Carter, E., L. Kola, J. Tomasouw, M. Wedgwood & R.A. Saraswati. 2018. Kondisi Laut: Indonesia Jilid Satu

Gambaran Umum Pengelolaan Sumber Daya Laut untuk Perikanan Skala Kecil dan Habitat Laut Penting di Indonesia.

Crona, B.I., X. Basurto, D. Squires, S. Gelcich, T.M. Daw, A. Khan, E. Havice, V. Chomo, M. Troell, E.A. Buchary & E.H. Allison. 2016. Towards a typology of interactions between small-scale fisheries and global seafood trade. Marine Policy. 65: 1-10. https://doi.org/10.1016/j.marpol.2015.11.016.

Damasio, LMA, M.G. Peninno & P.F.M. Lopes. 2020. Small changes, big impacts: Geographic expansion in small-scale fisheries. Fisheries Research. 226: 105533. https://doi.org/10.1016/j.fishres.2020.105533.

Daw, T.M. 2018. Spatial distribution of effort by artisanal fishers: Exploring economic factors affecting the lobster fisheries of the Corn Islands, Nicaragua. Fisheries Research. 90 (1–3): 17-25. https://doi.org/10.1016/j.fishres.2007.09.027.

Dwiponggo, A. 1991. Pernanfaatan dan Pengelolaan Optimal Perikanan Laut dalam pembangunan jangka Panjang Tahap II. Badan Litbang Pertanian Bekedasama Dengan USAID, Prosiding Forum-II Pertanian.

Ermayanti, E. 2015. Teknologi penangkapan ikan pada masyarakat nelayan di Nagari Pasar Lama Air Haji, Kecamatan Linggosari Baganti, Kabupaten Pesisir Selatan. Jurnal Antropologi: Isu-Isu Sosial Budaya. 17 (1): 23. https://doi.org/10.25077/jantro.v17i1.33

Espinosa-Romero, M.J., L.F. Rodriguez, A.H. Weaver, C. Villanueva-Aznar & J. Torre. 2014. The changing role of NGOs in Mexican small-scale fisheries: From environmental conservation to multi-scale governance. Marine Policy. 50: 290-299. https://doi.org/10.1016/j.marpol.2014.07.005

FAO 2010. Food Outlook 2010 (Issue 1).

FAO 2015. Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the context of Food Security and Poverty Eradication. Fao, 34.

FAO. 2019. Pedoman Sukarela Untuk Melindungi Perikanan Skala Kecil. Organisasi Pangan dan Pertanian dari Perserikatan Bangsa-bangsa.

García-Lozano, A.J & J.T. Heinen. 2016. Property relations and the co-management of small-scale fisheries in Costa Rica: Lessons from Marine Areas for Responsible Fishing in the Gulf of Nicoya. Marine Policy. 73: 196-203. https://doi.org/10.1016/j.marpol.2016.08.011.

Gio, P.U & A.R. Effendie. 2017. Belajar Bahasa Pemrograman R. Universitas Sumatera Utara Press. https://doi.org/10.31227/osf.io/ktmy2.

Guyader, O., P. Berthou, C. Koutsikopoulos, F. Alban, S. Demanèche, M.B. Gaspar, R. Eschbaum, E. Fahy, O. Tully, L. Reynal, O. Curtil, K.Frangoudes & F. Maynou. 2013. Small scale fisheries in Europe: A comparative analysis based on a selection of case studies. Fisheries Research. 140: 1-13. https://doi.org/10.1016/j.fishres.2012.11.008.

Ministry of Marine Affairs and Fisheries (MMAF). 2015. Peraturan Menteri Kelautan Dan Perikanan Republik Indonesia Nomor 2 Tahun 2015 tentang Larangan Indonesia Nomor 2 Tahun 2015 tentang Larangan Penggunaan Alat Penangkapan Ikan Pukat Hela dan Pukat Tarik di Wilayah Pengelolaan Perikanan Negara Republik Indone. In Kementerian Kelautan dan Perikanan Republik Indonesia. Kementerian Kelautan dan Perikanan Republik Indonesia.

Ministry of Marine Affairs and Fisheries (MMAF). 2018. Kelautan dan Perikanan Dalam Angka 2018 Kementerian Kelautan dan Perikanan Republik Indonesia.

Kusdiantoro, K., A. Fahrudin, S.H. Wisudo & B. Juanda. 2019. Perikanan tangkap di Indonesia: Potret dan tantangan keberlanjutannya. Jurnal Sosial Ekonomi Kelautan dan Perikanan. 14 (2): 145. https://doi.org/10.15578/jsekp.v14i2.8056.

Langdon, S.J. 2015. Foregone harvests and neoliberal policies: Creating opportunities for rural, small-scale, community-based fisheries in southern Alaskan coastal villages. Marine Policy. 61: 347-355. https://doi.org/10.1016/j.marpol.2015.03.007.

Mahmud, A & R.L. Bubun. 2015. Potensi lestari ikan layang (*Decapterus* spp.) berdasarkam hasil tangkap pukat cincin di Perairan Timur Sulawesi Tenggara. Jurnal Teknologi Perikanan dan Kelautan. 6 (2): 159-168. https://doi.org/10.24319/jtpk.6.159-168.

Munafi, L.O.A & A. Tenri. 2016. Strategi adaptasi nelayan dan perkembangan modernisasi perikanan di Kota Baubau. DIMENSI - Journal of Sociology. 9 (2). https://journal.trunojoyo.ac.id/dimensi/article/view/3748.

Pauly, D., V. Crhistensen, S. Guenette, T. Pitcher, U.R. Sumaila, C.J. Walters, R. Watson & D. Zeller. 2002. Towards sustainability in world fisheries. Nature. 418: 689-695. https://doi.org/10.1038/nature01017.

Prihandoko, A.J., D.S. Gani, I.G.P. Purnaba & L. Adrianto. 2011. Faktor-faktor yang mempengaruhi perilaku nelayan artisanal dalam pemanfaatan sumberdaya perikanan di Pantai Utara Provinsi Jawa Barat. Sosial Humaniora. 15 (2): 117126.

Rahim, Abd. 2016. Komparasi hasil tangkapan nelayan tradisional wilayah Pesisir Pantai Barat Kabupaten Barru. Jurnal Kebijakan Sosial Ekonomi Kelautan Dan Perikanan. 3 (1): 107. https://doi.org/10.15578/jksekp.v3i2.312.

RI. 2009. Undang-undang Republik Indonesia Nomor 45 Tahun 2009 Tentang Perubahan atas Undang-undang Nomor 31 Tahun 2004 tentang Perikanan. Pemerintah Republik Indonesia. https://doi.org/10.15957/j.cnki.jjdl.2009.07.004.

Satria, A. 2001. Dinamika modernisasi perikanan: Formasi sosial dan mobilitas nelayan. Humaniora Utama Press.

Sethi, S.A., M. Dalton & R. Hilborn. 2012. Quantitative risk measures applied to Alaskan commercial fisheries. Canadian Journal of Fisheries and Aquatic Sciences. 69 (3): 487-498. https://doi.org/10.1139/f2011-170.

Smith, I.R. 1979. A Research Framework for Traditional Fisheries. International Center for Living Aquatic Resources Management.

Vatria, B., B. Wiryawan, E.S. Wiyono & M.S. Baskor 2019. Cluster analysis of small-scale capture fisheries characteristic in North Kayong Regency. Marine Fisheries. 10 (1): 95-106.

Wicaksono, E & Effendi. 2019. Determinan efisiensi nelayan di Indonesia: Sebuah analisis stochastic frontier. Jurnal Sosial Ekonomi Kelautan dan Perikanan. 14 (1): 115. https://doi.org/10.15578/jsekp.v14i1.6868.

Zhang, C & Z. Fang. 2012. An improved K-means clustering algorithm. Journal of Information & Computational Sciences. 10(1): 193-199. https://doi.org/10.1109/ICIME.2010.5478087.

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