Participatory mapping: Assessing problems and defined marine conservation planning and zoning in Jor Bay, Indonesia

M A Al Amin¹,²,*, L Adrianto²,³, T Kusumastanto²,⁴, Z Imran²,³ and F Kurniawan²,³

¹Coastal and Marine Management Program, Graduate School, IPB University Bogor (Bogor Agricultural University), Kampus IPB Dramaga, Bogor 16680, Indonesia
²Center for Coastal and Marine Resources Studies (CCMRS), IPB University (Bogor Agricultural University), Kampus IPB Baranangsiang, Jl. Raya Pajajaran No. 1, Bogor 16127, West Java, Indonesia
³Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University (Bogor Agricultural University), Jl. Agatis, Kampus IPB Dramaga, Bogor 16680, Indonesia
⁴Department of Environment and Resources Economic, Faculty of Economy and Management, IPB University (Bogor Agricultural University), Kampus IPB Dramaga, Bogor 16680, Indonesia

*E-mail: arsyadalamin@pksplib.or.id

Abstract: Jor Bay Lombok is a marine protected area (MPA) which is initiated by local communities, which have a local-driven marine management regulation called *Awig-awig*. Unfortunately, the fisheries condition has continued to decline in the past decades, where the rate of exploitation of capture fisheries in Jor Bay shows an unbalanced condition because the harvest value is still higher than the recruitments and growth. *Awig-awig* regulates all existing utilization and protection of marine resources, but yet, has not included spatial aspects, leaving a situation that leads to unsustainability for fisheries resources and other resources. Balanced zoning of ecosystems and marine resources is needed in order to ensure the sustainability of the fisheries system in Jor Bay. This paper aims to illustrate how a marine spatial planning approach in a local MPA can be built with a community-based zoning system. The integration of local systems and formal-government systems is very effective and fast in the development of MPA zoning systems by considering the optimum allocation of the existence of ecosystems that guarantee the natural metabolic processes of the fisheries system in the Bay. The implementation of the MPA zoning system is expected to be able to support the guarantee of sustainable fisheries production for the surrounding region.

Keywords: participatory mapping; bay management; sustainable fisheries.

1. Introduction

Around the world, marine ecosystems show signs of distress, including drastically diminished fish stocks, habitat destruction and pollution. In order to address these and other marine environmental issues, many countries are conducting marine spatial planning (MSP) [1].
The Government of Indonesia is trying to protect marine resources to stop damage and restore to the environment and marine ecosystems, including habitat for fisheries resources, by reserving a conservation area of 20 million hectares by 2020 and 25 million hectares by 2025. Indonesia has made rules and guidelines to establish conservation areas and open up opportunities for anyone to initiate, be it individual, community, private, Non-Government Organization (NGO) or local government. However, these processes are very complex and must have the support and understanding of all parties. The community assumes that the existence of a conservation area is considered to limit the space for community activities, especially reducing the fishing ground area.

Indonesia has made rules and guidelines for establishing conservation areas and open up opportunities for anyone to initiate, be it individual, community, private, NGO or local government. However, these processes are very complex and must have the support and understanding of all parties.

Historically, Indonesian people have proven to have traditional fisheries management practices [2], and many of these community groups have local wisdom in managing and protecting natural resources, including coastal and marine, such as sasi, tiatiki, awiq-awiq, etc. The purpose of establishing a marine conservation area is to ensure the sustainability of fisheries resources by providing healthy habitats and ecosystems for the development of fisheries biota and the protection of marine ecosystems, as well as being targeted in sustainable development goals (SDGs target 14). The function of fisheries itself has three aspects, namely protecting and restoring fish stocks, supporting fishing livelihoods and feeds more people [3].

The community of Jor Bay area has the local knowledge-based rules on coastal and marine resources management called “Awiq-awiq”, and they had formed the Lembaga Pemangku Awiq Teluk Jor – Jor Bay regulatory authorities (LPATJ) as mandated institution to manage multi marine resources utilization including fisheries management. However, the Rules do not include zoning system yet. It makes LPATJ difficult to enforce the awiq-awiq. Due to the unclear zoning of bay, there is no specific area that was protected, therefore depleting and over-exploitation of resources is occurring continuously. It is necessary to be established MSP with zoning system which integrates local knowledge, scientific approach and government systems to build an effective MPA, as well as to manage sustainable fisheries in the bay.

MSP is a framework that informs the spatial distribution of marine resources, activities, uses, both existing and future based on ecological, economic and social objectives [4]. Zoning is a ubiquitous land use planning and regulatory mechanism whose purpose is to provide for orderly community growth and development by segregating land uses that are deemed incompatible. Zoning seeks to prevent new development from interfering with existing uses and, to preserve community “character”, but is also used to implement government plans and policies related to economic development and urban renewal [5]. Participatory mapping is an approach which can apply for identifying conservation areas necessary to safeguard the provision of important ecosystem services for indigenous communities [6].

We assume that the integration of local knowledge, scientific approach and government systems to build an MSP is very effective and faster to develop MPA zoning systems by considering the optimum allocation of the existence of ecosystems that guarantee the natural metabolic processes of the fisheries system in the bay. This study aims to illustrate how a participatory mapping is succeeded to define the cause roots of bay management issues and problems and established MSP in a local MPA by zoning system.

The integration of local knowledge systems and formal-government systems is very effective and faster to develop MPA zoning systems by considering the optimum allocation of the existence of ecosystems that guarantee the natural metabolic processes of the fisheries system in the bay. This paper illustrates the process of prioritizing spatial zoning led by stakeholders for a small area known as Jor Bay on Lombok Island, informed by science and supported by a systematic conservation planning

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1 Awiq-awiq is a set of regulation for managing resources based on local knowledge/wisdom.
approach. This process has been sufficiently helpful to ensure that the resulting biodiversity planning is adequately represented in the expansion of protected areas and embed the results into wider land-use decision making, including working with local communities.

2. Materials and methods

2.1. Study area

The geographic setting for this study was Jor Bay, which is located at East Lombok West Nusa Tenggara Province, Indonesia, encompasses 1,007.96 hectares (Figure 1). The study was conducted in January - December 2018.

![Figure 1. Map of the research site in Jor Bay Lombok Indonesia](image)

2.2. Data collection

The study was conducted by using participatory planning and mapping for a marine conservation area. LPATJ initiated conservation program in Jor Bay as a local NGO who has mandated to manage the bay, in collaboration with academician group who join-led the systematic conservation planning process. Participatory mapping is a type of public participation that includes the generation and/or use of spatial information for a variety of purposes. Participatory mapping is highly variable in design and implementation [7]. In this study, to facilitate participatory mapping, the community formed a Working group (*kelompok kerja – Pokja*). *Pokja* were formed consist of from the representatives of community, stakeholders and policymakers to support all planning process. *Pokja* quickly grew to
consist of representatives from all of the community groups, government representative, as well as village governmental agent. Every stage of the planning process, i.e. collecting data, defining the issues and problems, a survey to resources mapping, analysis and zoning were reviewed by Pokja and consulted to stakeholders and policymakers by Meeting and Focus Group Discussion (FGD), particularly in zoning process to ensure the spatial prioritization allocation. We consulted with stakeholders and policymakers as well as Village Government during every stage of the planning process to ensure the spatial prioritization remained relevant.

Data collected are both spatial-ecological and social data. Both spatial data are collected by the participatory method. This method is needed to support the processes and stages of spatial planning [8]. Geographic Information System (GIS) is a system used as a decision support tool that can assist in making decisions to determine the spatial allocation in MSP by identifying various options for areas that require special management, both protected areas or core zones and fishing areas.

1) Social Data
Social data includes all human activities that are used to identify important community activities related to the utilization of marine resources. The data include all existing community activities in the areas, such as capture fisheries, mariculture, sea transport, tourism, etc. Social-spatial data were generated through participatory mapping, satellite image analysis, and field observations and ground checkpoint using Global Positioning System (GPS) involving the local community. Participatory mapping methods can assess the consistency, compatibility, and potential conflict of zoning with public values and preferences in a general plan revision process using a coastal community [5]. Therein lies the basis for what is, in fact, local knowledge and tradition of viewing natural resource sectors.

2) Ecological Data
Ecological data are necessary to identify the importance of habitat and ecosystem quality for biodiversity conservation and delivery of ecosystem services [8]. The data covers the distribution and quality of coral reef, seagrass meadow mangrove, coastal and small islands. Ecological-spatial data were obtained through participatory mapping, satellite image analysis and field surveys using the line intercept transect (LIT) method for coral reef ecosystems, and quadratic transects for coral reef, mangrove and seagrass ecosystems [9], and then also involves the local community.

2.3. Analysis

2.3.1. Issues and Problems Analysis
FGD collects the issues and problem and following by snowball technique to in-depth problems roots. The connectivity and relation among the problems found then analysed using DPSIR (Driver, Pressure, State, Impact and Response) tools. DPSIR is framework comprises a systematic approach to environmental management by exploring the interdisciplinary links among socioeconomic drivers, environment-related pressures, state of the environment, impacts of environmental changes and, finally, social responses to combat environmental degradation [10].

2.3.2. Zoning Analysis

1) Defining indicators and targets
The indicators are based on Guideline for the Preparation of Management and Zoning Plans for Marine, Coastal and Small Islands Protected Areas [9], especially in ecological and social indicators, adapted to existing conditions in the Jor Bay area. Targets for core zones are made up of at least 2% of the total area (1,007.96 hectares) to optimize conservation objectives. Locally, zoning systems are also built on existing rules, community activities, and conservation actions.
Based on the workshop and community consultations recommendations [11], the prioritized conservation option should be:

a. focus on Jor Bay's importance ecosystem, explicitly including threatened species;
b. incorporate the mangrove ecosystem;
c. consider *awiq-awiq* rule; and,
d. consider new activities development, especially marine tourism.

2) Overlay analysis

Zoning analysis was generated using the overlay method from the ecological and social data and consensus. In the overlay processes, the data combination is a valuable step in spatial allocation explicitly to multiple users and coastal biodiversity conservation and identifying trade-off. Then, the result of overlaying is reaffirmed based on the result of scientific assessment by the condition of ecological quality and community utilization activities (as calibration), so the conflict of spatial allocation can be avoided. To reassure the results, a public consultation was held again to establish the agreed zoning system.

The stakeholders have been agreed that due to data availability, the map of species distribution needs to be developed, and the spatial analysis use Marxan, a software package designed to identify sets of priority areas that meet quantitative targets for specified conservation features while minimizing costs and maintaining connectivity [12, 13]. All stakeholders were kept up-to-date and remained involved as the spatial conservation prioritization was developed and completed.

![Figure 2. A number of Fishermen in the Bay.](image-url)
3. Result and discussion

3.1. Socio-ecological system profile of Jor Bay

3.1.1. Social system

Administratively, Jor Bay covers two villages, namely Paremas and Jerowaru Villages which are divided into seven sub-villages (SV) (Poton Bako, Telong elong, Jor, Tutuk, Permas, Keranji and Gili Belek), the number of inhabitants around Jor Bay is 16,528 peoples and 4,030 households, which is Paremas Village 3,025 inhabitants (680 households). The Jerowaru village has 13,503 inhabitants (3,350 households) with a density of population is 807.11 inhabitants/km$^2$. There were 820 fishers in the Bay (210 in Jerowaru and 610 in Paremas) (Figure 2), and there was 217 mariculturist in total who taking activity in the bay for two villages (Figure 3) [14].

3.1.2. Ecological system

Jor Bay have plenty and complete coastal ecosystems, such as mangroves, coral reefs and seagrass beds, each of which has interrelated functions to support fisheries activities in Jor Bay [14-16]. Map of the distribution of the three ecosystems in Jor Bay shown as Figure 4. There is no zoning recently; current utilization of the Bay is only for fishing and mariculture. The distribution map of the utilization of the bay is shown in Figure 5.
Figure 4. Distribution of coastal ecosystem (coral, mangrove and seagrass).

Figure 5. Distribution variant of existing utilization of the bay.
1) Mangrove
Mangrove ecosystem around Jor Bay has ± 82.36 hectare, Kecebing Bay ± 128.71 hectares and Telone ± 27.17 hectare. The results of several studies indicate that the level of density of Mangrove resources around the Jor Bay, Kecebing Bay and Telone regions has a moderate category [16].
Mangrove ecosystems in Jor Bay are almost evenly spread along the coast of Jor Bay. Mangrove ecosystem vegetation in Jor Bay consists of five types of mangroves: *Avicennia alba*, *Ceriops tagal*, *Rhizophora mucronata*, *Rhizophora stylosa*, and *Sonneratia alba* (Table 1).

| No | Species                      | S1  | S2  | S3  | S4  | S5  | S6  | S7  |
|----|------------------------------|-----|-----|-----|-----|-----|-----|-----|
| 1  | *Avicennia alba*             | -   | √   | √   | √   | √   | -   | -   |
| 2  | *Ceriops tagal*              | -   | -   | -   | -   | √   | *   | -   |
| 3  | *Rhizophora stylosa*         | -   | -   | -   | √   | √   | -   | -   |
| 4  | *Rhizophora. mucronata*      | √   | √   | √   | -   | -   | √   | √   |
| 5  | *Sonneratia alba*            | √   | √   | √   | √   | √   | √   | √   |

Source: [17]
Note: S1 = in Poton Bako sub-village; S2 = in Telong Elong sub-village; S3 = in Jor sub-village; S4 = in Tutuk sub-village; S5 = in Permas-I sub-village; S6 = in Permas-II sub-village; S7 = in Keranji sub-village; √ = found; * = not found; * = found out the transect.

Table 2. Mangrove densities at the tree level in Jor Bay.

| Species                      | Density (ind/ha) |
|------------------------------|------------------|
|------------------------------|------------------|
| *Avicennia alba*             | 0 467 367 800 1,200 0 0 |
| *Ceriops tagal*              | 0 0 0 0 0 0 0 |
| *Rhizophora stylosa*         | 0 0 0 233 67 0 0 |
| *Rhizophora mucronata*       | 3,867 0 2,133 0 0 1,367 267 |
| *Sonneratia alba*            | 667 2,333 300 1,567 2,700 1,333 2,733 |
| Total                        | 4,534 2,800 2,800 2,600 3,967 2,700 3,000 |

Source: [17].
Note: the location (S1-S7): S1 = in Poton Bako sub-village; S2 = in Telong Elong sub-village; S3 = in Jor sub-village; S4 = in Tutuk sub-village; S5 = in Permas-I sub-village; S6 = in Permas-II sub-village; S7 = in Keranji sub-village.

Table 3. Mangrove densities at stake level in Jor Bay.

| Species                      | Density (ind) |
|------------------------------|---------------|
|------------------------------|---------------|
| *Avicennia alba*             | 0 300 33 1,100 800 0 0 |
| *Ceriops tagal*              | 0 0 0 0 100 0 0 |
| *Rhizophora stylosa*         | 0 0 0 0 200 0 0 |
| *Rhizophora mucronata*       | 1,833 33 1,600 0 0 400 1,633 |
| *Sonneratia alba*            | 367 2,367 100 433 1,200 1,233 733 |
| Total                        | 2,200 2,700 1,733 1,533 2,300 1,633 2,367 |

Source: [17].
Note: the location (S1-S7): S1 = in Poton Bako sub-village; S2 = in Telong Elong sub-village; S3 = in Jor sub-village; S4 = in Tutuk sub-village; S5 = in Permas-I sub-village; S6 = in Permas-II sub-village; S7 = in Keranji sub-village.

Based on Table 1, it was shown that *Sonneratia alba* was found in all stations. Another species that is also found in almost all stations is *R. mucronata*. The beaches with mud substrate type were dominated by *S. alba*, while beaches with mud and sand substrate type were dominated by *R.
and *R. stylosa*. The tree-level density in Poton Bako SV is the highest density with a value of 4,534 ind/ha, while the lowest density of the tree level is found in Tutuk SV with a density value of 2,600 ind/ha [17]. An assessment of mangrove density at the tree, stake, and seedling level in Jor Bay is presented in Table 2 and Table 3.

### Table 4. Mangrove densities at a seedling level in Jor Bay.

| Species          | S1 | S2 | S3 | S4 | S5 | S6 | S7 |
|------------------|----|----|----|----|----|----|----|
| *Avicennia alba*  | 0  | 0  | 67 | 1,133 | 233 | 0  | 0  |
| *Ceriops tagal*   | 0  | 0  | 0  | 0   | 0   | 0  | 0  |
| *Rhizophora stylosa* | 0  | 0  | 0  | 167 | 200 | 0  | 0  |
| *Rhizophora mucronata* | 800 | 133 | 1,833 | 0   | 0   | 1,333 | 0  |
| *Sonneratia alba* | 0  | 400 | 0  | 600 | 967 | 0  | 0  |
| **Total**        | 800 | 533 | 1,900 | 1,900 | 1,400 | 1,333 | 0  |

Source: [17].

Note: the location (S1-S7): S1 = in Poton Bako sub-village; S2 = in Telong Elong sub-village; S3 = in Jor sub-village; S4 = in Tutuk sub-village; S5 = in Permas-I sub-village; S6 = in Permas-II sub-village; S7 = in Keranji sub-village.

In all locations, the density of mangrove species was categorized as good (dense), especially at the tree and stake level. This shows that the condition of mangrove ecosystems in Jor Bay is still relatively good. The highest density at the tree, stake, and seedling level was found in Species *R. mucronata*. Meanwhile, the lowest density was found in species *C. tagal* at the level of trees, stake, and seedling. This assessment refers to the Decree of the Minister of Environment No. 201/2004, the criteria for the density of mangrove species at a value of <1,000 ind/ha, including the rare (damaged) category, 1,000 - <1,500 ind/ha including the medium (good) category and ≥ 1,500 ind/ha is included in the very solid (good) category [9].

![Important Value Index (IVI/INP) of mangrove in Jor Bay.](image-url)
R. mucronata is one of mangrove species that have high adaptability; this causes R. mucronata to grow and survive more easily. This condition was also confirmed by fisher and communities in Jor Bay, where most of the R. mucronata species in Jor Bay, especially at Poton Bako SV were the result of community planting, mangrove vegetation at the site looks neatly arranged which shows it is the result of rehabilitation and not natural growth.

The influence and role of mangrove type in the community are described by the Importance Value Index (IVI/INP) (Figure 6). INP values are calculated using vegetation analysis consisting of values of relative density, relative frequency and relative closure. INP values range from 0-300. The mangrove species with the highest INP in Jor Bay is the S. alba species found at in Keranji SV while the lowest INP is the R. stylosa species found at Permas-I SV.

Species S. alba and R. mucronata dominate in almost all observation locations. The distribution of S. alba species increased when the location led to the mainland and at the location has relatively small waves and a greater amount of mud. Different research was found the different data that the INP of S. alba is the highest value of INP, which is dominated by the type of S. alba. This data shows that during 2016-2018 there were no significant changes when viewed from the mangrove structure [18]. However, if viewed from the perspective of species density, it can be said that there has been a positive growth of the mangrove ecosystem. This condition is seen in the difference in the value of mangrove density in 2016 [18], mangrove density was 867 ind/ha, while in 2018 (this study) mangrove density was known to be 3,200 ind/ha. When viewed from the density value of each type of stand, it is suspected that there has been positive growth in the mangrove ecosystem. This status can be seen from the increase in the number of trees in 2018 when compared to 2016, and conversely a decline in the number of seedlings in 2018. In more detail, changes in the value of mangrove density from 2016 to 2018 are presented in Table 5.

**Table 5.** Changes in the mangrove density of Jor Bay from 2016 to 2018.

| Type of Mangrove | Mangrove density (ind/ha) |
|------------------|---------------------------|
|                  | Year 2016<sup>1)</sup>   | Year 2018<sup>2)</sup> |
| Trees            | 867                       | 3,200                     |
| Stake            | 2,533                     | 2,067                     |
| Seedling         | 99,167                    | 1,124                     |

Source: <sup>1)</sup>[17], <sup>2)</sup>[18].

2) **Coral reef**
Coral reefs found around Jor Bay which include Jor Bay itself, Kecibing Bay, and Telong Elong waters are about 78.47 hectares with an average living coral cover percentage of 43.30% (33.98 hectares) which the damaged cover of 56.70% (44.49 hectares). Live coral reefs consist of Hard Coral (Hard Coral) and Soft Coral [17].

3) **Sea Grass**
The seagrass ecosystem for the Jor Bay community is one of the important fishing areas, especially fishermen with a gill net, fishing and traditional fishing gear called "madak" [14]. Utilization of seagrass ecosystems is currently limited to the fishing ground. Seagrass ecosystems in Jor Bay are found in the outer bay waters of the left side around Sub-Village Telong Elong and Sub Village Paton Bako [17].

4) **Fish Resources**
Fish resources in Jor Bay are very diverse. There are several types of fish found both in inner and outer bays. In addition to the potential for fish farming, Jor Bay also has a high potential for capture fisheries. This can be seen from the catches of fishermen with catchment areas around Jor Bay. In the mangrove ecosystems of Jor Bay there is much meroplankton, and fish larvae found. The mangrove
ecosystem in Jor Bay is used as a place to enlarge fish larvae before they finally mature and return to the sea [19]. There are several types of fish obtained around the bay, as shown in Table 6. Some types of fish that are often used by surrounding communities include snapper (Lutjanidae), grouper (Serranidae), Lethrinidae, and Haemulidae [15].

Table 6. List of fish resources in Jor Bay.

| No | Local name      | Common name          | Scientific name              |
|----|-----------------|----------------------|------------------------------|
| 1  | Amang jaran     | Slender worm eel     | Muraenichthys gymnotus       |
| 2  | Api-api         | Spotted sicklefish   | Drepane punctata             |
| 3  | Bante           | Parrot fish          | Scarus sp.                   |
| 4  | Bante basong    | Parrot fish          | Scarus sp.                   |
| 5  | Bante bontet    | Parrot fish          | Scarus sp.                   |
| 6  | Baronang        | Smudespot spinefoot  | Siganus guttatus             |
| 7  | Belanak         | Green black mullet   | Planiliza subviridis         |
| 8  | Blungkusian     | Pink shrimpgoby      | Cryptocentrus leptocephalus  |
| 9  | Bulu baby       | Sea urchin           | Salmacis sparamoides         |
| 10 | Bunge waru      | Yellow-lined snapper | Lutjanus rufo lineatus       |
| 11 | Cepak - cepak   | Japanesa trevally    | Carangoides uii              |
| 12 | Cotek keras     | Ponyfish             | Leiognatus sp.               |
| 13 | Cotek lemes     | Toothphony fish      | Gaza minuta                  |
| 14 | Empak antap     | Double ended pipe fish | Syngnathoides biculeatus    |
| 15 | Empak setoek    | Twinspot flounder    | Pseudorhoribus diplospilus   |
| 16 | Galigase        | Sergeant major       | Abudefduf vaigiensis         |
| 17 | Gronggong       | Gold spotted trevally| Carangoides fulvoguttatus    |
| 18 | Joget           | Longfish bannerfish  | Heniochus acuminatus         |
| 19 | Kakap           | Indonesian snapper   | Lutjanus bitaenius           |
| 20 | Kepiting bakau  | Mud crab             | Scylla serrate               |
| 21 | Kerang          | Blood cockle         | Anadara granosa              |
| 22 | Kerapu macan    | Brown marbled grouper| Ephinephelus fuscoguttatus   |
| 23 | Kerapu rangah   | Blacktip grouper     | Ephinephelus fasciatus       |
| 24 | Kerong kerong   | Terapon              | Terapon sp.                  |
| 25 | Langgor         | Pennantfish          | Allectis ciliaris            |
| 26 | Merelah         | Blue lined surgeon fish | Acanthurus lineatus       |
| 27 | Monar/teri      | Anchovy              | Stelophorus sp.              |
| 28 | Ngom            | Orbicular cardinal fish | Sphaeramia orbicularis     |
| 29 | Pari karang     | Blue spotted fantail stingray | Taeniura lymma |
| 30 | Piyo            | Goatfish             | Parupanneus sp.              |
| 31 | Rebon           | Paste shrimp         | Acetes sp.                   |
| 32 | Sange           | Long nosed unicorn fish | Naso brevirostis            |
| 33 | Semulang        | Stripped eel catfish | Plotosus japonicus           |
| 34 | Serpik          | Whitespot spinefoot  | Siganus cannaliculatus       |
| 35 | Strie           | Lion fish            | Pteoris sp.                  |
| 36 | Tambak          | Pink ear emperor     | Lethrinus lenjan             |
| 37 | Tambak losoh    | Emperor fish         | Lethrinus sp.                |
| 38 | Tambak sronteng | Blackspot snapper    | Lutjanus fulvilama           |
| 39 | Tamban          | Smooth belly sardine | Amblygaster leigaster        |
| 40 | Tawes           | Oxeye herring        | Megalops cyprinoides         |
| 41 | Tawor           | Barred garfish       | Hemirampus fur               |
| 42 | Unduk-unduk     | Spiny sea horse      | Hyppocampus hystrix          |

Source: [15].
3.2. Problems mapping

There are at least three key elements that will have an impact-related with the issues and problem on society to manage a conservation area such as Jor Bay: societies, economies and communities dependent on environmental services and natural resources always have an ecosystem, human and management/governance components to them. One cannot properly understand a coupled human-nature system without taking an integrated approach that incorporates these multiple considerations. Therein lies the basis for what is, in fact, a long tradition of viewing [20]. The problems found in Jor Bay are complex, but briefly cause four main problems: (a) degradation of Jor Bay resources, (b) declining productivity of waters and ecosystems, (c) low community welfare and (d) ineffective Jor Bay management institutions. By using the DPSIR approach, the main issues, problems and its the connectivity among the problems in Jor Bay were asses and the Defined cause roots issues and problems in Jor Bay as Figure 7.

![Diagram](image)

**Figure 7.** The Issues, problems and its connectivity.

3.3. Community-Based Zoning System of Jor Bay

The recommended outcome of discussions and consultations between the parties is that conservation activities should: i) focus on the habitat and biodiversity of Jor Bay, explicitly including threatened species; ii) determine the specific location allocated for each community activity; and iii) consider the role of local communities to be involved in managing including monitoring their implementation. The stakeholders also agreed that complete data and maps of the ecosystem and species distribution need to be as detailed as possible. All stakeholders are always informed and must continue to be involved when spatial conservation priorities are developed and implemented. The decision zoning system agreed by the parties in the MPA Jor Bay area is as table 7.
### Table 7. Proposed zoning and MPA areas in Jor Bay, result from community consensus.

| Zoning                        | Ecosystem Type                  | Location                                                                 |
|-------------------------------|--------------------------------|--------------------------------------------------------------------------|
| Core zone                     | Coral                           | Gili Kuri Island, Aruk, Taket Sebu                                         |
|                               | Seagrass                        | Gili Kerate Island, Madak Limbung Pandan                                  |
|                               | Mangrove                        | Tutuk SV, Poton Bako SV                                                  |
| Rehabilitation zone           | Seagrass                        | Gili Ree island, Madak Bengkok, Gili Kuri, Island Gili                     |
|                               | Coral                           | Belek Island, Keranji SV                                                  |
|                               | Mangrove                        | Permas, Keranji (Less/damage)                                            |
| Utilize zona/sustainable      | Mariculture                     | Ambit Telong – Elong – Permas, Ambit Gili Ree – Gili                      |
| fishing zone                  | Capture fisheries              | Belek Island, Ambit Poton Bako, Ambit Keranji                             |
| Utilize zona/tourism zone     | Snorkelling/diving              | Gili Kuri Island and Gili Butak Island                                   |
|                               | Culinary                        | Gili Mangkem Island                                                       |
|                               | Mangrove track                  | Tutuk SV, Keranji, Poton Bako SV                                         |
| Transportation channel zone   | Port/transportation             | Uj. Bt. Putek                                                            |
|                               | Port/Jetty                      | Permas SV and Jelok Mengkuru                                             |
| Sea Transportation lane       |                                 | Telong – Elong SV, Orong Tutuk SV, Gili Mangkem strait, Jor – Kuri Island |

Source: Community consensus decision on a spatial plan, 2018.

The area determined for each designation zone within the Jor Bay’s MPA area is divided into four zones as shown in Table 8. The zoning system in the marine protected area (MPA) in Jor Bay is spatially shown in Figure 8.

### Table 8. Zoning system on the Jor Bay and area determined based on community consensus.

| Zoning system                  | Area (Ha) | Proportion (%) |
|--------------------------------|-----------|----------------|
| Core zone                      | 31.04     | 3.08           |
| Utilization zone; Tourism      | 51.06     | 5.07           |
| Utilize zone: Mariculture zone | 48.70     | 4.83           |
| Sustainable fisheries zone     | 877.16    | 87.02          |
| Total area                     | 1,007.96  | 100            |

The community in Jor Bay has been agreed in consensus on the allocation of space intended for ecosystem protection while still paying attention to the interests of the people who use bay resources as their source of livelihood. This success story also provides evidence that the Community in Jor Bay has successfully used the participatory mapping method [5], that participatory mapping can assess data and information as well as the consistency, compatibility and potential of zoning conflicts with consideration and preference of the public interest in the process improvement plans that will provide benefits to coastal communities.
4. Conclusions
By participatory local community-based approach combined with a scientific-technological based support, a marine spatial plan (MSP) with a zoning system in a marine protected area (MPA) in Jor bay is more easily formed and accepted by the community to strengthen the enforcement of Awiq-awiq in Jor Bay. MSP in Jor Bay is very important as an instrument to manage the bay so that it can accelerate the effectiveness of MPA zoning implementation optimally so that in addition to preserving the marine ecosystem, it also ensures that the natural metabolic processes of the fisheries management system can continue to work sustainably.

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