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Connectivity of the social-ecological system of the blue swimming crab fisheries in Rembang

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Connectivity of the social-ecological system of the blue swimming crab fisheries in Rembang

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Abstract. The management of blue swimming crabs requires several aspects to be considered, such as social and ecological aspects for the sustainability of small crab fisheries. Fishery management is currently still focused on economic interests, so if this is allowed to continue, it will result in ecosystem degradation. This study aims to determine the components of the social-ecological system of the blue swimming crab fishery and the interrelationships of the crab management factors in Lasem District, especially in Gedongmulyo Village, Rembang from March to June 2023 using a purposive sampling method, including socio-economic data and fishermen's interviews. Analysis of social-ecological connectivity including resource systems (RG), resource units (RU), resource actors (RA), and resource governance (RG) subsystems, and analyzes management variables using the participatory prospective analysis (PPA) method. The results show the connectivity of the social ecological system of the blue swimming crab fishery in Lasem between Resource Actors and Resource Systems, Resource Units, and Resource Governance. While Resource Governance is negatively related to the Resource System. Re-education about the regulations for the use of non-environmentally friendly fishing gear, the impact on the environment, and fishermen's awareness of the need to comply with these regulations needs to be carried out.

Keywords: blue swimming crab; ecology; participatory prospective analysis; social

1. Introduction

Rembang is a regency in Central Java with a high potential for crab fisheries. Geographically, Rembang is located at the eastern tip of Central Java Province and is passed by the Java North Coast Road (Pantura Line) at coordinates 111° 00′ - 111° 30′ East Longitude and 6° 30′ - 7° 6′ South Latitude [1]. Rembang Regency has a strategic location for crab fisheries commodities because it is located in the North Java Sea and is passed by the Pantura Route, so the resources and transportation of these commodities are very supportive. One of the areas in Rembang that has high potential for crab management is the Lasem sub-district. Several villages in Lasem district have fishermen with various fishing gear and several mini plants spread over five villages, namely Gedongmulyo, Dasun, Tasiksono, Bonang, and Binangun.

Ideal fisheries management is needed to achieve sustainable fisheries. According to [2], there are three aspects of ideal fisheries management: fisheries resources with ecosystems, utilization of fisheries resources for the socio-economic community, and these two components cannot be separated and are interrelated. Fisheries management is currently still focused on economic interests, so if this is allowed to continue, it will result in ecosystem degradation [3].

The Social Ecology System (SES) approach, or social-ecological connectivity, is the concept of the relationship between human systems and ecological systems. The concept of socio-ecology is the concept of the interrelationship between human systems and ecological systems. The two systems are interdependent on one another, so changes in each system will affect the other [3, 4]. Currently, it is not yet known which components influence the management of crab fisheries in the Lasem and Rembang areas, so it is necessary to conduct research directly to determine the interrelationships between components in Lasem, one of the areas that has high crab fisheries management.

2. Methods

2.1. Study area

This research was conducted in Gedongmulyo Village, Lasem District, Rembang Regency, from March 2023 to June 2023. The location for data collection focused on Gedongmulyo Village because there were many fishermen with environmentally friendly (traditional) fishing gear, three large collectors, and two mini plants, so blue swimming crab is one of the main catches besides squid. Gedongmulyo Village has fishermen with trammel nets, traps, and mini trawls. Additional information regarding crab commodities was obtained from relevant stakeholders, namely collectors, villages, and the Rembang Regency Maritime and Fishery Service Office.

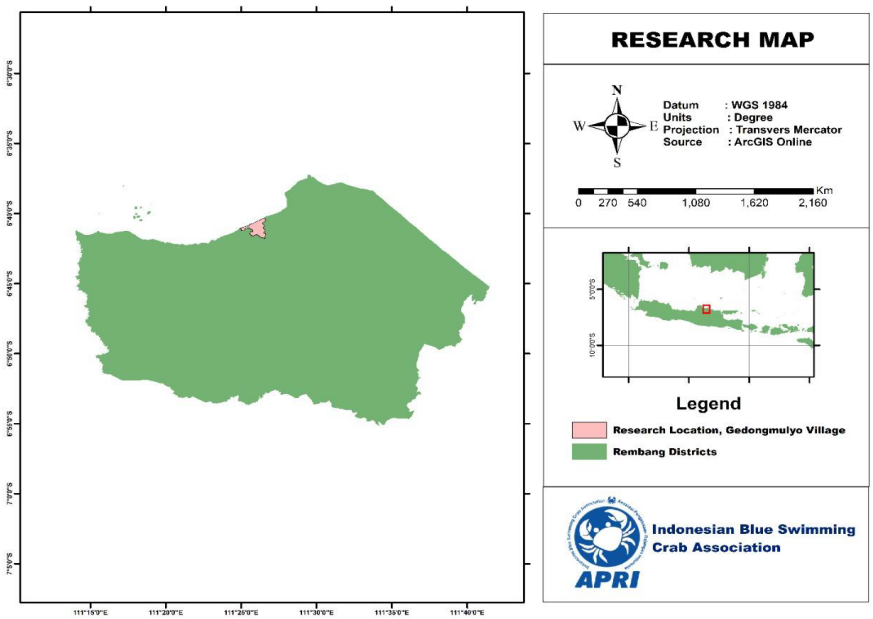

Figure 1. Map of the research location.

2.2. Data collection

Data collection was carried out for fishermen, collectors, village government, and the Rembang Regency Maritime and Fisheries Service. Primary data was obtained by conducting interviews with coastal communities using a purposive sampling method. The purposive sampling method was used because of the special criteria used in determining the respondents, namely blue swimming crab fishermen with environmentally friendly fishing gear. The number of respondents was 30, consisting

of fishermen, coastal communities, and collectors. Other information regarding the management of the blue swimming crab fishery was obtained through discussions with the village government and the Rembang Regency Maritime and Fisheries Service.

2.3. Data analysis

Data analysis was processed descriptively through three approaches, namely socio-ecological connectivity, management systems, and management strategies [3]. Socio-ecological connectivity includes the relationship between subsystems. The management system is one of the factors that influences crab fishing activities. The management strategy describes the positive and negative relationships between existing subsystems for the creation of an appropriate, sustainable management strategy.

3. Results and discussion

3.1. Socio-ecological connectivity

Analysis of socio-ecological connectivity uses the method according to [5], which uses four subsystems, namely the Resource System (RG), Resource Unit (RU), Resource Actor (RA), and Resource Governance (RG). A resource system (RS) is the environmental condition and ecosystem management of an area. Objects managed in an area are called Resource Units (RU). All of these subsystems will then be managed and utilized by the Resource Actor (RA). Other parties who have an interest in and control over governance in an area are called Resource Governance (RG). Each of these subsystems or components has an interdependent or reciprocal relationship, so they cannot be separated from one another.

Crab fishing in Rembang waters is generally carried out at a distance of 2–12 miles from the shoreline by trap fishermen and pejer nets, but in trammel nets, fishing is carried out more than 12 miles. According to fishermen and other coastal communities, the marine area in Rembang was damaged due to mini trawls operating along the Rembang Sea because they damage the seabed and catch fish larvae. The use of trawlers can damage the marine environment or marine resources because fishing is carried out without regard to environmental aspects. The presence of trawls will damage marine potential in the short and long term. Marine products (food security) will be depleted because fish regeneration is interrupted due to large-scale fishing, which can create conflicts between communities [6]. Regulations regarding the prohibition of using cotok nets to catch fish in the waters of the Rembang Sea are regulated in Regional Regulation (Perda) Number 14 of 2001 [7].

In the villages of Gedongmulyo and Dasun, there are mangroves along the river that function to prevent abrasion. The mangrove ecosystem in the coastal area can be said to be maintained, according to the fishermen, because mangroves have been planted on the beach several times. The ecosystem in the Rembang area is a component of the Resource System. The main catches (Resource Units) of fishermen in Lasem are blue swimming crab, squid, and fish. The crabs caught by the fishermen will be sold directly to the fishermen, who will then process them in the mini plant. The price of blue crab changes according to the market, which is in the range of IDR 50,000–IDR 100,000 per kg. The crab season in Rembang is very varied; usually in the west season, the crab will be abundant, but in the east season, the crab experiences a famine. The seasonal pattern influence the abudance of blue swimming crab in Rembang, the west season had a high abudance of crab compared to the east season [8]. According to the fishermen, the stock of crabs in nature has decreased from year to year due to the use of ripper fishing gear, so their income decreases. Parties directly related to the utilization of blue swimming crab (the resource actor) are fishermen and collectors. Fishermen as fish catchers influence the production of crabs caught in an area, and collectors as parties who distribute the crabs, so that the market and range of crab sales expand. The crabs obtained by collectors will be distributed to mini plants, which will be forwarded to crab processing companies after being processed into meat. Majority of the blue swimming crab supply chain actors generally consist of fishermen, mini plants, and processing companies [9].

Socio-ecological connectivity between each component of the Resort System (RG), Resource Unit (RU), Resource Actor (RA), and Resource Governance (RG) The Resource System (RS) produced 12 reciprocal connectivity points in the blue swimming crab fishery in the Lasem sub-district (Figure 2).

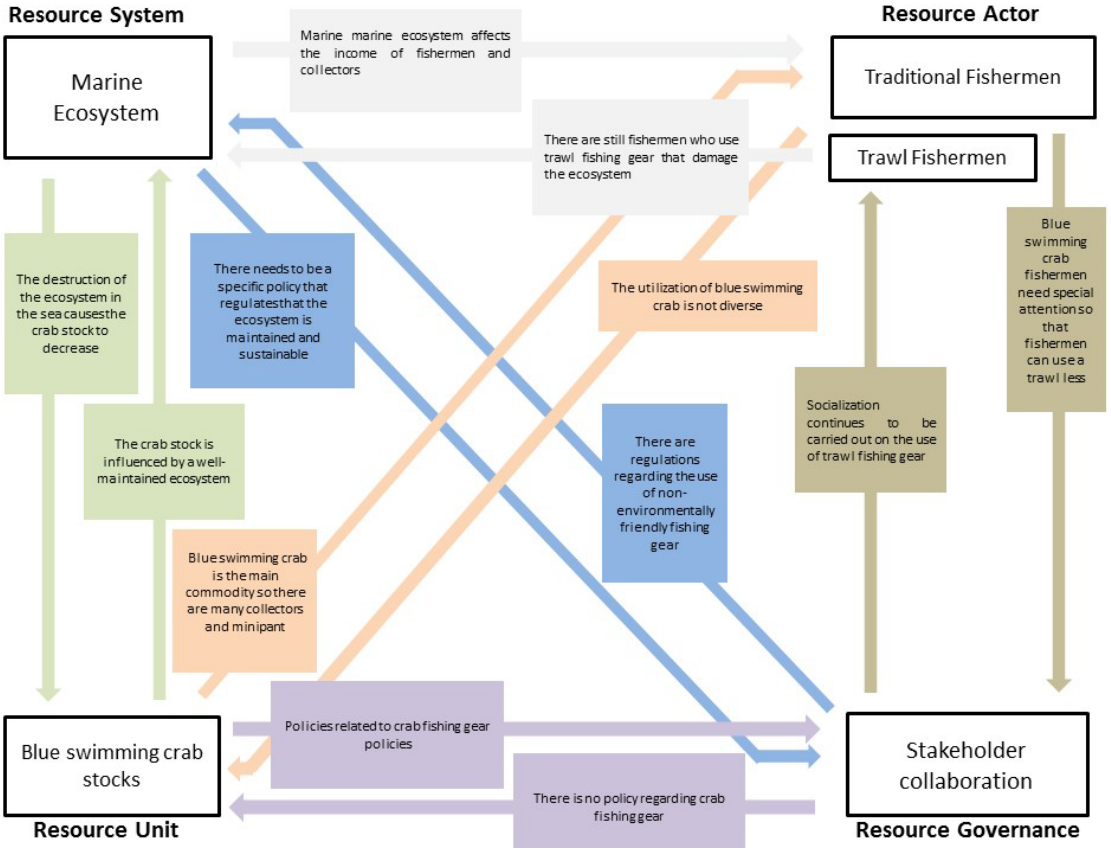

Figure 2. Socio-ecological connectivity of the blue swimming crab fishery in Lasem.

Connectivity between RS and RU, namely a good marine ecosystem, affects crab catches in the Lasem sub-district. The connectivity between RU and RS means that the crab catch will decrease if the crab ecosystem is damaged. The connectivity between RS and RA is that the damage to the ecosystem in the sea is caused by fishermen using a mini trawl, so that the income of environmentally friendly fishermen can decrease. The connectivity between RA and RS is that there are still fishermen who use mini trawl, which can damage the marine ecosystem. The connectivity between RS and RG is the need for policies related to fishing gear so that the marine environment is maintained. The connectivity between RG and RS is to continue to make regulations governing marine ecosystems so that they are maintained and sustainable. Connectivity between RA and RG, namely crab fishermen, needs special attention so that crab catches are maintained by regulating pecker fishermen who damage the environment. The connectivity between RG and RA is one of continued socialization regarding regulations regarding the use of mini trawl fishing gear. The connectivity between RU and RA is that blue swimming crab is the main commodity, so there are many beneficiaries, such as collectors and mini-plants. The opposite connectivity between RA and RU, namely the use of blue swimming crabs, has not varied. The connectivity between RU and RG is that the crab fishery needs special attention so that the crab stock remains sustainable. The opposite connectivity between RG and RU is that there is no policy that regulates the rules for using crab fishing gear.

3.2. Management system

The management system is analyzed using the PPA (Participatory Prospective Analysis) method to determine the level of importance of various existing factors. The PPA (Participatory Prospective Analysis) method is a comprehensive operational framework that is used to find out about well-structured anticipation and exploration efforts that focus on interaction and policy making [10]. Determining the variables used in the PPA method is carried out by conducting discussions with fisheries stakeholders, including the village government and the Rembang Maritime Affairs and Fisheries Service.

Data analysis using PPA uses 7 categories that are directly related to blue swimming crab management in Lasem, namely marine ecosystems, income, weather and climate conditions, crab prices, crab stocks in nature, trawl, and stakeholder collaboration. PPA results can be seen in Figure 3.

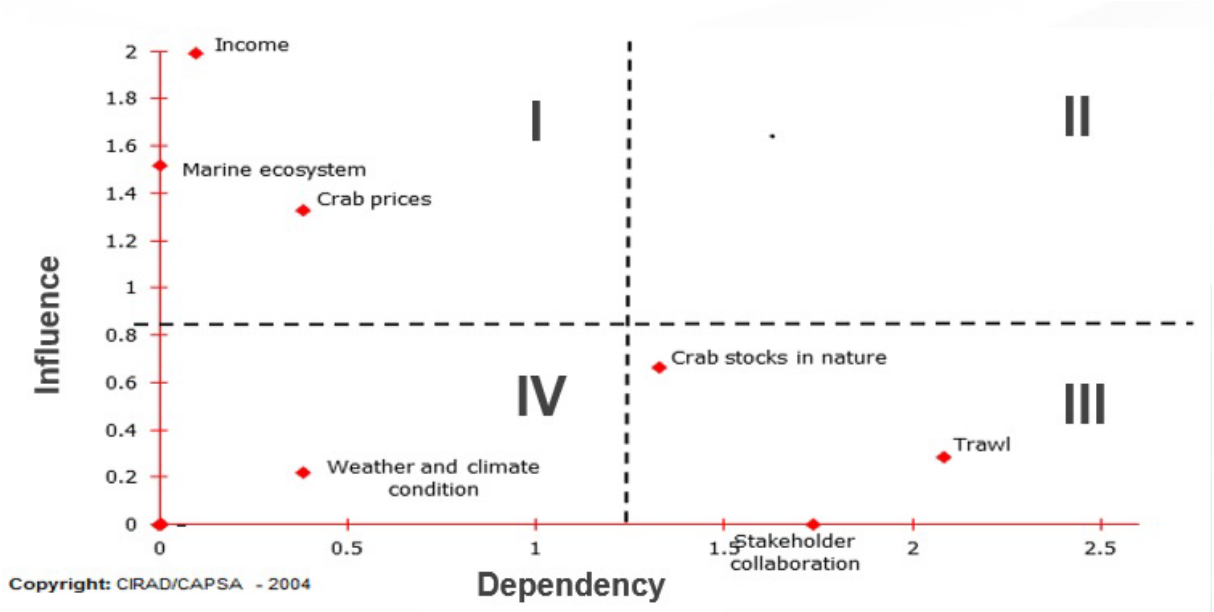

Figure 3. Participatory Prospective Analysis (PPA) of blue swimming crabs in Rembang.

Aspects in quadrant I are the determining aspects of the blue swimming crab fishery, namely income, crab prices, and marine ecosystems. Quadrant II is a linking factor for crab fisheries. There is no connecting factor for crab fisheries here. Quadrant III is dependent on three factors: stock swimming crabs in nature, the existence of mini-trawler fishermen, and stakeholder collaboration. Aspects in quadrant IV are independent factors and can be ignored, namely weather and climate conditions.

The results of the Participatory Prospective Analysis (PPA) processing of the blue swimming crab in Rembang were spread over three quadrants. The sustainability and preservation of marine ecosystems such as coral reefs, seagrasses, and mangroves needed to be considered so that the blue swimming crab fishery remained sustainable and the prices and income of fishermen could increase. The existence of aspects included in quadrant III depended on the aspects contained in quadrants I and II. It was known that the use of mini trawls needed to be regulated again because it significantly impacted the ecosystem, income, and crab prices in Rembang. Crab caught using mini trawls had poor meat quality, so the price would be cheaper than fishermen using environmentally friendly fishing gear. Mini trawls also affected the catch of fishermen using environmentally friendly fishing gear because small crabs were also caught. The standard of crab meat used as raw material for pasteurized products was meat of excellent quality that could be improved by catching a larger size of crab and proper handling [8, 11]. The role of stakeholders there was indispensable for ecosystem sustainability and the regulation of fishing gear. Prohibiting and enforcing the ban on destructive fishing gear was still challenging due to the need for

strong enforcement and surveillance and the limited budgets of the local government [12]. Weather and climate conditions in quadrant IV were independent variables that had an impact on fishermen not being able to go to sea because of bad weather. During the western season, the catch and income of fishermen decreased. The changes in weather or climate felt by fishermen, such as high waves, strong winds, and rainfall, made fishermen not have fishing time, or if they had fishing time, they would get minimal catches [13].

3.3. Management strategy

The management strategy is made based on the relationship between components (Resorce System (RG), Resource Unit (RU), Resource Actor (RA), and Resource Governance (RG)) in the Social Ecology System (SES) according to [5]. The linkages between components are indicated by a positive (+) if the components have a good relationship and a negative (-) if the opposite occurs. The relationship between components can be seen in Table 1.

Table 1. Interrelationships between components.

No	Interrelationships	Sign
1	*Resource System - Resource Actors*	(+) (-)
2	*Resource System – Resource Unit*	(+) (+)
3	*Resource System – Resource Governance*	(+) (-)
4	*Resource Actors – Resource Unit*	(-) (+)
5	*Resource Actors – Resource Governance*	(-) (-)
6	*Resource Unit – Resource Governance*	(+) (+)

The relationship formed between RS and RA is the opposite because currently there are still fishermen who use the pecker as their main fishing gear, so if used continuously, it will result in the destruction of the crab habitat in the sea. RS and RU are mutually positive because the marine environment influences crab stocks in nature, so both are mutually beneficial. The relationship between RS and RG has the opposite relationship because enforcement regarding the use of prohibited fishing gear, namely trawls, is still not firm. The relationship between RA and RU also has the opposite sign because some fishermen who use a pecker are not aware that continuous fishing using this fishing gear can lead to overfishing, so the crab catch will decrease every year. The relationship between RA and RG has a negative sign because currently compliance with crab catching, use of fishing gear, and application of policy regulations is not optimal. RU and RG are positive because the government fully supports and often socializes the importance of crab survival.

4. Conclusion

Participatory Prospective Analysis (PPA) produces three main variables that influence the management of crab fisheries in the future, namely marine ecosystems, income, and crab prices. Damage to the marine ecosystems has an impact on fishermen catches and income. The connectivity of the social and ecological systems of the crab fishery in the management strategy still has a negative relationship between Resource Actors and the other three components (Resource System, Resource Unit, and Resource Governance). Education and enforcement of regulations regarding the use of non environmentally friendly fishing gear by fishermen is the right strategy so that the marine ecosystem remains maintained and sustainable.

Acknowledgments
Thank you to all parties who participated in assisting the research, namely the community, fishermen, collectors, village government, Marine and Fisheries Service of Rembang Regency, and APRI, who assisted in the completion of this research. Hopefully, the research results can be used as a reference source for sustainable crab fishing policies.

References

[1] Rembang Regency Government. 2022. *Geographical location of rembang*. https://rembangkab.go.id/geografis/

[2] Charles A 2001 *Sustainable Fishery Systems* Oxford (UK): Blackwell Science.

[3] Waranti A 2022 Socio-ecological system connectivity of crab fishery in the coastal area of Tirtayasa District, Serang Regency, Banten Province [Thesis] Bogor(ID): Bogor Agricultural University.

[4] Virapongse A, Brooks S, Metcalf EC, Zedalis M, Gosz J, Kliskey A, Alessa L 2016 *Jenviron Manage* **178** 8391 **DOI** 10.1016/j.jenvman.2016.02.028.

[5] Ostrom E 2009 *Science* **325** 419-422 **DOI** 10.1126/science.1172133

[6] Wijayanto D, Setiyanto I, Setyawan HA 2019 *Aquaculture, Aquarium, Conservation & Legislation* **12**(5) 1823-1831

[7] Regional Regulation No. 14/2001 about Prohibition of the Use of Cotok Nets to Catch Fish in Rembang Marine Waters. https://drive.google.com/uc?export=download&id=1pFiAFk9xfd_AjGMWJJmXF8RatSRg70jj

[8] RP Utomo, P Maulana, MW Taqiyuddin 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1251** 012048 DOI 10.1088/1755-1315/1251/1/012048

[9] Setyaningrum P, Gabriel A, Cholilie I 2022 *Industria: Jurnal Teknologi dan Manajemen Agroindustri* **11**(2) 151-164.

[10] Bourgeois R and Jésus F 2004 *Participatory prospective analysis: exploring and anticipating challenges with stakeholders* (No. 1437-2016-2016-118895)

[11] Yusuf M 2007 Marketing study and development of value-added products by utilizing blue swimming crab in processed products [Dissertation] (Semarang: Diponegoro University)

[12] Nabila AN, Taurusman AA, Wiryawan, B, Riyanto M 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1137** 012021 **DOI** 10.1088/1755-1315/1137/1/012021

[13] Mulyasari G, Waluyati LR, Suryantini A 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **724** 012094 **DOI** 10.1088/1755-1315/724/1/012094