JKAP (Jurnal Kebijakan dan Administrasi Publik)
Vol.24 (2), November 2020, 162-179
ISSN 0852-9213 (Print), ISSN 2477-4693 (Online)
Available Online at https://journal.ugm.ac.id/jkap

Sustainable Coral Reef Ecosystem Management in Palopo City Territorial Waters

Muhammad Bibin
Faculty of Science and Technology, Universitas Muhammadiyah Sidenreng Rappang
muhbibin@umsrappang.ac.id

Fenny Hasanuddin
Faculty of Science and Technology, Universitas Muhammadiyah Sidenreng Rappang
fennyhasanuddin96@umsrappang.ac.id

Ani Ardian
Master of Public Administration, Faculty of Social and Political Sciences, Universitas Muhammadiyah Sidenreng Rappang
aniardian@umsrappang.ac.id

Abstract

Damage to coral reefs in the waters of Palopo City poses danger to the productivity of the habitat. Therefore, carrying out the adopting the principles of a conservation in the use and management of coral reefs in Palopo City area waters through an integrated system and participation of multi-stakeholders is considered imperative. The study analyzed the level and causes of damage coral reefs, assessed the role of stakeholders in managing coral reef ecosystems, and formulated a strategic model for managing coral reef ecosystems in Palopo City waters. Methods of data analysis included assessment of coral reef condition, stakeholder analysis, and hierarchical analysis. Result showed that fishing activity using environmentally unfriendly gear such as fish bombs and potassium is one of the principal causes of damage to coral reefs in the waters of Palopo City. Most damage occured to coral reefs at a depth of 4 meters at station 1, which registered a the percentage of the mortality index of 82.07%. Meanwhile, the least damage was 69.73%. At the depth of 4 meters station two is Result of stakeholder mapping identified three groups inter alia, contest setters, key players, and subject. The first priority strategy in the management of coral reef ecosystems in the waters of Palopo City should be designate the zoning of coastal areas, coordination among stakeholders that are relevant and important with respect to coral reef ecosystems power relations, drafting local regulations that mandate sustainable use and management of coral reef ecosystems and increasing training programs for fishing communities.

Keywords: *Management; Priority Strategy; Coral Reefs.*

INTRODUCTION

Intensive and rapid development activities in coastal areas have increased the threat that coral reef ecosystems face (Yulianda et al. 2010). This is because, increase in economic activities poses serious danger to coral reef ecosystems due to excessive exploitation. In general, damage to coral reefs can occur naturally (*autogenic*), such as earthquakes, storms, tsunamis, global warming and the effects of climate change as well as due to human activities (*anthropogenic*). Human activities that can cause damage to coral reefs include the excessive taking of corals for building materials, fishing activities using environmentally damaging fishing gear, tourism activities, land conversion for coastal areas and marine pollution (Webler and Jakubowski 2016).

The damage to the coral reef ecosystem can undermine the capacity of the ecosystem as a source of resources in coastal and marine areas, such as the loss of spawning areas and foraging for marine life and the reduction of fish (Saphier and Hoff-mann 2005). Besides, the adverse impact also includes the loss of the physical function of coral reef ecosystems such as wave absorbers/breakers and preventing seawater surges and inundation (Valderrama Ballesteros, Matthews, and Hoeksema 2018). To that end, restoring the functions of coral reef ecosystems requires, adopting an integrated and sustainable management of coastal areas, especially coral reef ecosystems (Chang, Hong, and Lee 2008).

Palopo City is one of the areas in South Sulawesi Province that has immense coral reef potential. The ecosystem covers coral reef Palopo City water area is 172 Km^2 in area, and 21 Km^2 along the beach (Anon 2018). Palopo City was designated an administrative city as part of Luwu Regency. However, in 2002 based on Law No. 11 2002, Palopo reverted to the status of at town (Anon 2020). The immense potential of marine and fishery resources, biological, non-biological and environmental services alike, which areas in the vicinity of makes, Palopo City an attractive area for economic activities. Nonetheless, the increase in economic activities in the area has created dangers for biodiversity in Palopo City. This is especially so with respect to the iridescent and beautiful coral reef ecosystem. Fishing using ecologically damaging fishing gear, is one the key causes of the rising damage to coral reef ecosystem.

Damage to coral reefs in the Palopo City coastal area will certainly have adverse impact on area. Subsequently, the ramifications of local communities, especially traditional fishermen who depend on coral reef resourcesfor livelihood is likely to be very dire. Thus, there is need for Palopo City to adopt sustainable use and management of the coral reefs ecosystem along its coastal area. Considering the importance of sustainable management practices in supporting environmental biodiversity, good coral reef management

must incorporate and cover ecological, social, economic and institutional aspects. Status of management and use of Palopo City waters, this paper aimed at obtaining the general picture about the condition of coral reefs in the area, identify problems that relate to coral reef management, and based on findings of the study, recomended solutions that can help to solve such problems. Specifically, this study being motivated by the increase in the damage to coral reef ecosystem in Palopo City coastal area as a result of the rapid increase in economic activities in general and fishing using unsustainable methods, in particular, the purpose of this study was to analyze the form and causes of damage coral reef ecosystem in Palopo City waters, map and apportion roles of stakeholders in the management of coral reef ecosystems in Palopo City seas and strategic model for sustainable management of coral reef ecosystems in Palopo City waters.

METHODS

The research used is a mixed research design, which combined quantitative and qualitative data collection and analysis techniques. Primary and secondary data were used during the research process. Primary data were obtained by conducting direct observation. Meanwhile, secondary data were collected using literature review of previous research, official reports and documents from various institutions and governments. The following sub section describes techniques that were used to collect data that were later used in analysis to answer the research question and purposes of the research.

1. Used Underwater photo transect (UPT) method to observe the condition of coral reef ecosystem direct observation.
2. In depth interviews were used to collect social, economic, and demographic data. Purposive sampling was used to determine respondents who were interviewed. The study conducted interviews with eight respondents, who are stakeholders with respect to the use and management of coral reef ecosystem in Palopo City coastal waters. Stakeholders included the local government, non-governmental organizations and local communities.

Meanwhile, data analysis tecniques that were used included, analysis of the condition of coral reefs using Coral Point Count with Excel Extension (CPCe) application (Kohler and Gill 2006). CPCe a standalone application that can automatically conduct random point calculation analysis and is also able to perform necessary substrate calculations on images taken underwater. In addition, CPCe can generate a statistical analysis for each form of coral growth in Microsoft Excel spreadsheet. Stakeholders analysis each stakeholder plays an important role in policy formulation, which depends on influence wielded. Stakeholder analysis involves several steps, according to Ramirez

Table 1. Criteria of Stakeholder Interests

Score	Criteria	Description
5	Very high	Have very high interest in coral reef ecosystem management
4	High	Have high interest in coral reef ecosystem management
3	Modest/neither high nor low	Have quite high interest in coral reef ecosystem management
2	Less high (low)	Have little interest in coral reef ecosystem management
1	Very Low	Have no interest in coral reef ecosystem management

Source: (Reed et al. 2009)

cited in (Bibin, Vitner, and Imran 2018). These include, namely:

a. Identification.
b. Create a table containing information on the register.
    1. Interests, as manifested in motives and attention toward policy. To determine the importance of actors that actors attach to a certain policy, the Likert scale is used. The Likert scale used consisted of five levels, that ranged from 1 (low) to 5 (very high). High level is associated with strong importance attached to coral reef ecosystem management while very low denotes low importance attached to the policy in Palopo City (Table 1).
    2. Determining the level of influence. Influence is based on economic, social, ecological, and institutional aspects inter alia.
c. Subsequent step involved conducting grid actor mapping (Figure 1) to determine the level of importance and influence stakeholder attach to coral reefs ecosystem management policy. Issues that influence the position of the stakeholder in the quadrant depends on category of subject, whether or not he or she is a key player, whether is just part of

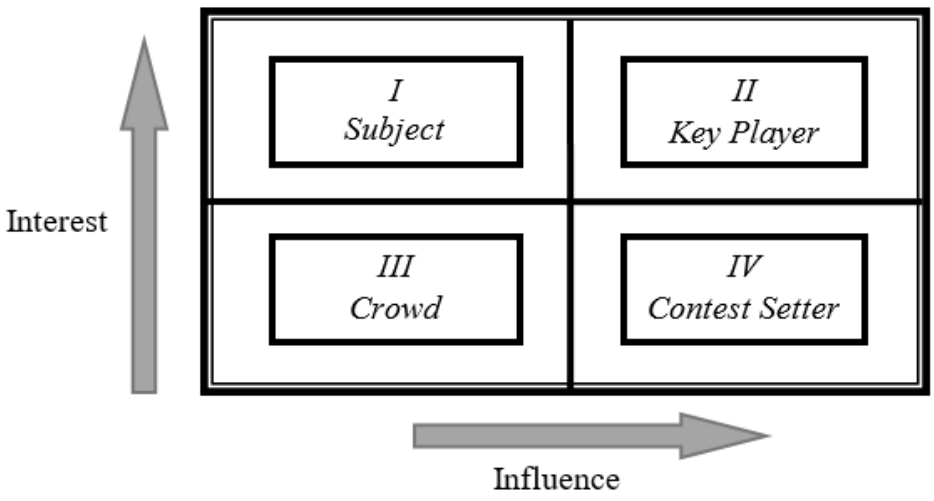

Figure 1. *Stakeholders* influence and interest matrix
Source: Modified by Researchers, (2020)

the crowd, or contest setter (Reed et al. 2009). Thus, the conduct of stakeholder was intended to identify and assess roles stakeholders play in influencing policy in general and resource use on matters of coral reef ecosystem use and management in Palopo City coastal waters.

Conducting hierarchy process analysis (AHP). This step entails conducing simultaneous qualitative and quantitative assessments. Policy priority setting in AHP involves, capturing people's perceptions and converting intangible factors into ordinary/ categorical measures to facilate comparisoned. Figure 2 shows the hierarchical process in determining strategies for coral reef ecosystems management in Palopo City coastal area waters.

FINDINGS AND DISCUSSION

1. The Condition of Palopo City Territorial Waters

Environmental conditions constitute one of the key limiting factors for the coral reef ecosystem. The limiting factor affects the distribution and growth of coral reefs. Based on (Nybakken 1988) research, water quality parameters have interdependent relationship between one another. Table 2 illustrates the quality of Palopo City coastal waters.

a. Brightness radiated by Palopo City coastal waters

Based on the results of measurements in the research location, the level of water

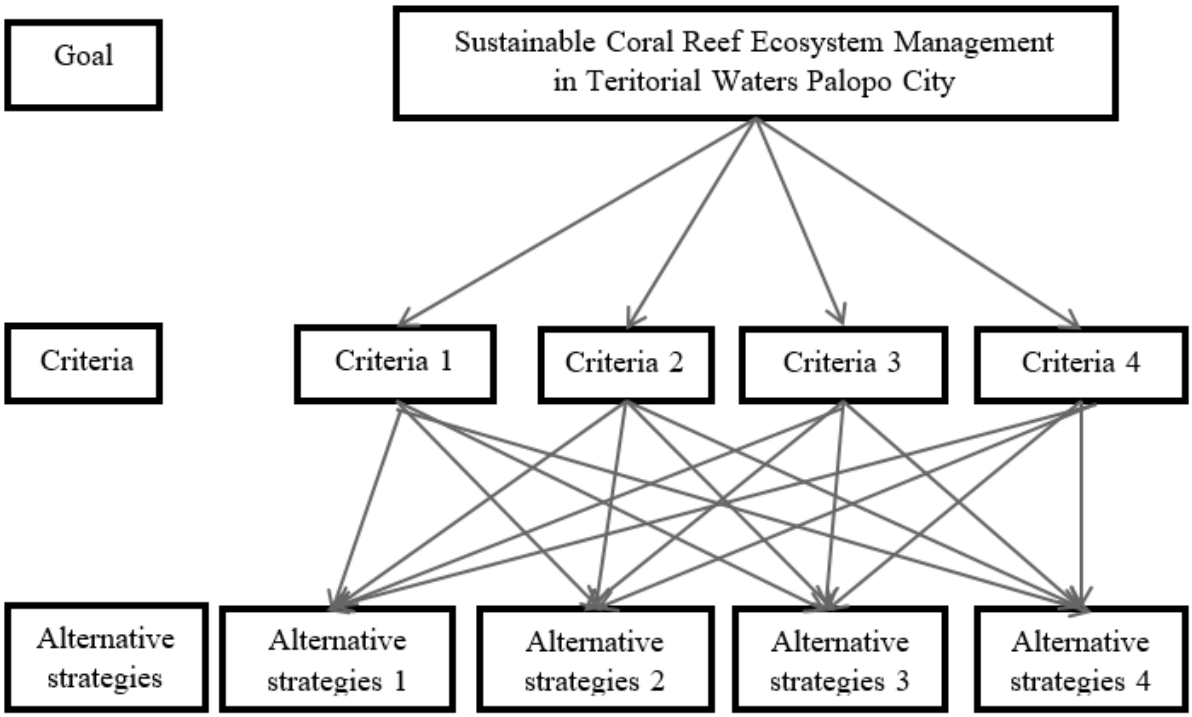

Figure 2. Hierarchy of determining strategies for coral reef ecosystem management

Source: Primary data, (2020)

Table 2. Quality of Palopo City coastal waters

Parameters	Station 1 (4 – 9 m)	Station 2 (4 – 9 m)	Station 3 (4 – 9 m)
Brightness (%)	72	74	81
Temperature	30	30	30
Flow Velocity	0.16	0.16	0.18
Salinity	31	31	31

Source: Primary data, (2020)

transparency falls within the from 72-81% range. The range in the effects is attributable to the differences in depth in each observation station. The compensation point for coral reefs is at the a depth at which light intensity is approximately 15-20% of the surface intensity (Yulianda et al. 2010).

b. Temperature in Palopo City coastal waters

Water temperature at the three observation stations is around 30ºC. Temperature results fall under the excellent category for the survival and reproduction of coral reefs. Water temperature is an essential factor that determines the life of coral reefs. This is related to the growth and development of coral biota (*coral polyps and zooxanthellae*). The coral biota can still tolerate a maximum annual temperature of around 36ºC-40ºC and a minimum temperature of 18ºC. Coral reefs grow well at an optimum temperature of 25º-29ºC and survive up to a minimum temperature of 15ºC and a maximum of 36ºC (Estradivari, Handayani 2017).

c. Flow velocity in Palopo City coastal waters

Based on measurements obtained at the research location, current velocity at the falls in the 0.16-0.18 m/s range, which falls under the slow flow category. Dead current category lies in the speed range of 0-0.25 m/s, the intermediate current category falls in the speed range of 0.25-0.50 m/s, fast current category has speed range of 0.25-1 m/s and speedy current category has speed that is above 1 m/s. Currents are benefical for coral reefs as they facilitate the removal of nutrients, larvae and sediment, while flow helps in cleaning up trash. Meanwhile, current velocity and turbulance also affect the general morphology and taxonomic composition of coral reef ecosystem (Tomascik et al. 1997); (Yulika Sari and Usman 2012).

d. Salinity in Palopo City coastal waters

The salinity at the observation location was 31‰(°°). Thus, salinity measurement result attest to the fact that conditions still support the growth and development of coral reefs. In general, coral reefs can grow well at a salinity of 30-35‰(°°) in coastal areas (Tuwo 2011).

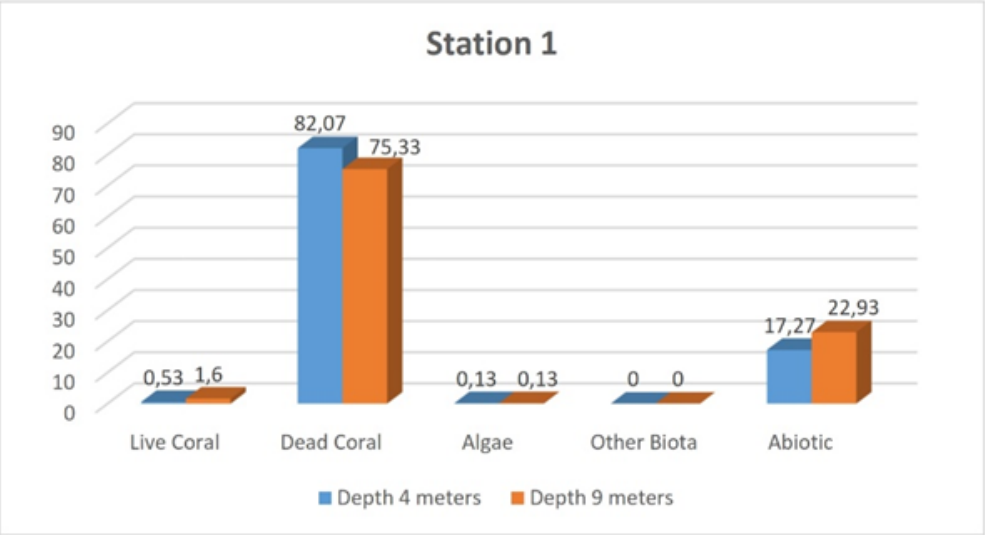

Figure 3. Condition of coral reefs at station 1
Source: Primary data, (2020)

2. The Condition of Coral Reefs in Palopo City Coastal Waters

The existence of coral reefs in Palopo city coastal waters can be found at a depth of between 4 meters and 9 meters. Observation of the coral reef ecosystem in Palopo City waters was conducted using the underwater photo transect (UPT) method. The underwater photo transect method is an advanced development of LIT and PIT methods. At the depth 4 meters at station one the percentage of live corals was 0.53%, 82.07% were dead corals, 0.13% covered by algae, 0% and 17.27% other biotas and abiotic species, respectively. Meanwhile, at a depth of 9 meters, the percentage of live coral cover was 1.6%, dead coral was

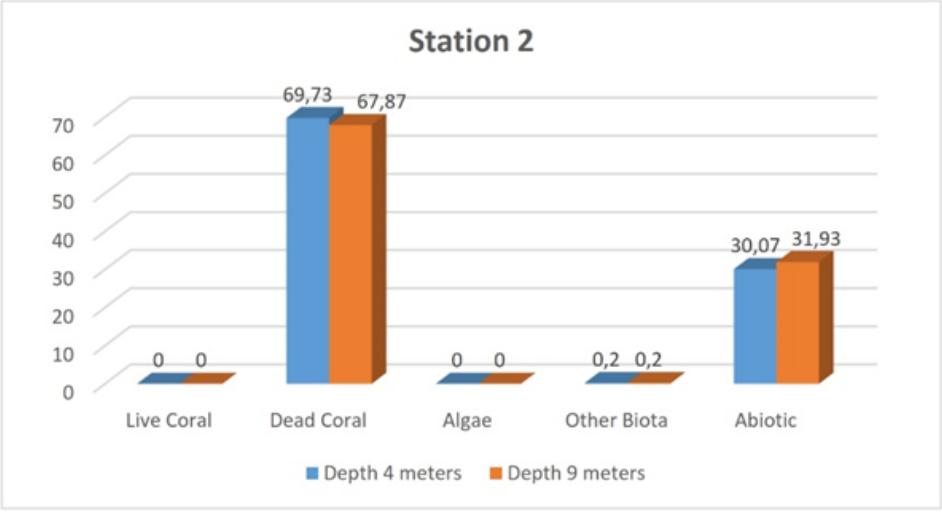

Figure 4. Coral reef condition at station 2
Source: Primary data, (2020)

75.33%, algae was 0.13%, another biota and abiotic 0%, and 22.93% respectively.

Observation of coral reef conditions at station two was carried out at a depth of 4 and 9 meters. Result showed that the percentage of live coral cover at a depth of 4 meters was 0%, 69.73% was dead coral, 0% algae, other biotic and abiotic, 0.20% and 30.07%, respectively. In comparison, at a depth of 9 meters, the percentage of live coral cover was 0%, 67.87% was dead coral, 0% algae, other biotic and abiotic species, 0.20% and 31.93%, respectively.

Observation of coral reef condition at station three was made at a depth of 4 and 9 meters. Result showed that the percentage of live coral cover at a depth of 4 meters was 7.37%, dead coral 82.04%, algae 0%, other biotic and abiotic species, 0.80% and 9.79%, respectively. Meanwhile, at a depth of 9 meters, live coral cover of was 11%, dead coral 69.47%, algae 0%, other biotic and abiotic species 0.40% and, 19.13% respectively.

Based on the criteria for assessing the condition of coral reefs set by the then ministry of environmental protection (MENLH 2001) No. 4 Year, the inference from result obtained from measurements of the condition of corals cover in Palopo City waters is that between 0% and 24.9% of coral can be categorized as damaged/sour. One of the major causes of damage to coral reefs in the waters of Palopo City is the existence of community activities that have damaged coral reefs in the past. Economic activities that have damaged corals in the past include, fishing using environmentally destructive fishing tools such as fish bombs and potassium that cause serious damage to healthy coral reefs. This is reflected in the high percentage of dead corals of 67.87%-82.07%. Bombing activity breaks and destroys the coral skeleton, leading to excessive high pressure to which coral can not adopt short time. This is corroborated in

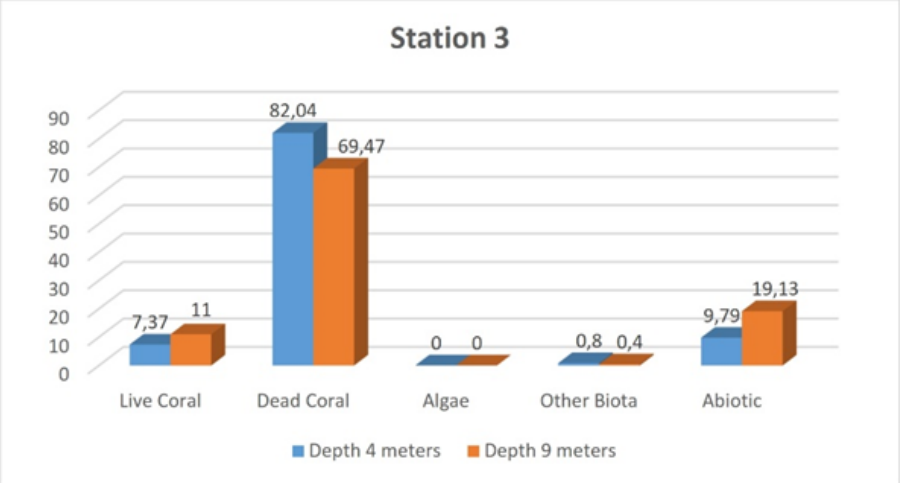

Figure 5. The condition of coral reefs at station 3
Source: Primary data, (2020)

previous research (Crosby, Brighouse, and Pichon 2002) that found that a large number of human activities in coral reef areas, especially when fishing using explosives, are responsible for breaking and destroying corals.

3. Level of Influence and Interest of Stakeholders

The success of management activities in an area is strongly influenced by the ability and willingness of stakeholders to be play their roles in serving their interests in a responsible manner. Stakeholders also influence management activity through impacting on who carries out what, conditions of carrying out activities, and incentive for doing so (Sunahwati, Maarif, and Sukmawati 2019). Thus, the management of coral reefs ecosystem in Palopo City waters will work well if the conduct of its activities gets the support of stakeholders inter alia, the community, government, and non-governmental organizations (Singgalen, Wiloso, and Sasongko 2017).

a. Identification of stakeholders

The role played is dynamic and depends on position, and exercising of the rights and obligations that are associated with the position (Soerjono 2004). Roles various stakeholders including government agencies, non-governmental organizations and the community, play influence the management of coral reef ecosystems in Palopo City waters. The results of the exercise of identifying stakeholders involved in coral reefs management in Palopo City coastal waters can be describe as follows:

1) The Mayor of Palopo City

The Mayor of Palopo is a stakeholder who has the authority to determine policies on enhancing the protection of areas designed as protect, enforce environmental preservation and improvement of function of protected areas.

2) Palopo City Spatial PlanningAgency

Palopo City spatial planning office is responsible for spatial planning and zooning of the utilization of coastal areas.

3) Palopo City Regional Development Planning Agency

The Palopo City Regional Development Planning Agency (BAPPEDA) has the primary duties of assisting the Regent/ district head in determining policies in the field of coral reef area management planning and assessment of its implementation, compiling strategic plans (RENSTRA) in Palopo City and coordinate planning among government agencies, regional technical institutions, and non-governmental organizations (NGOs).

4) Palopo City Marine and Fisheries Agency

The department of marine and fisheries Palopo City is responsible for formulating and implementing policies that relate to coral reef management to ensure sustainability of use, supervise community activities to prevent irrevocable damage to coral reefs, and provides guidance/assistance to communities on sustainable utilization of coral reef

ecosystems.

5) Palopo City Environmental Service

Palopo City Environmental Service is responsible for formulating, implementing and evaluating policies, that relate to coral reef utilization.

6) Non-Governmental Organizations

Non-governmental organizations (NGOs) conduct research that generates result that inform policy on improving the management of coral reef ecosystems Palopo City waters. Besides, NGOs, support, criticize government policies on coral reef ecosystem management, monitor policy implementation through forums that aggregate, accomodate, and ventilate community aspirations into the public policy process.

7) Academics

Academia help in providing research based information and knowledge on the effective management of coral reef ecosystems in Palopo City waters, preservation of coral reef ecosystems, evaluate and provide inputs and feedbacks to government policies on coral reefs ecosystem management.

8) Local Communities

Local communities are indigenous people who exercise social control over government policy. This form of social control is also a source of criticism and suggestions on improving existing government policies on coral reef ecosystem management.

b. Mapping Stakeholder

Stakeholders involved in managing coral reef ecosystems in Palopo City have varying levels of interest and power. To that end, it is necessary to map interests and power of stakeholders with respect to the management of various coral reef ecosystems. (Almutairi et al. 2018) underscores the importance of mapping stakeholders, which is pivotal for identifying the roles play in the policy process as well as identifying information on roles, interests, knowledge, expectations, and influence levels they have.

Based on the influence (power) and interests (interest), the stakeholders involved in the management of coral reef ecosystems can be categorized into three groups, inter alia, key players, subjects, and contest setters. Figure 6 shows the stakeholders map in managing coral reefs in the Palopo City coastal waters.

1) Stakeholders: Key Players

Stakeholders who have interest (interest) and influence (power) levels are classified as Key Players (Quadrant II). To quality for this category, stakeholders must be actively involved in policy planning and evaluation (Maxwell and Filgueira 2020); (Reed et al. 2009); (Lu et al. 2017). (Yehong et al. 2017) underlines the fact that the, key player group of stakeholders should play the most most critical role in the policy. In the case of coral reefs policy management, key players include the Mayor of Palopo, Palopo City Marine Affairs and Fisheries Agency, Palopo City, the Palopo City Regional Development Planning Agency, Palopo City Spatial Planning Service, Palopo City Environmental Agency.

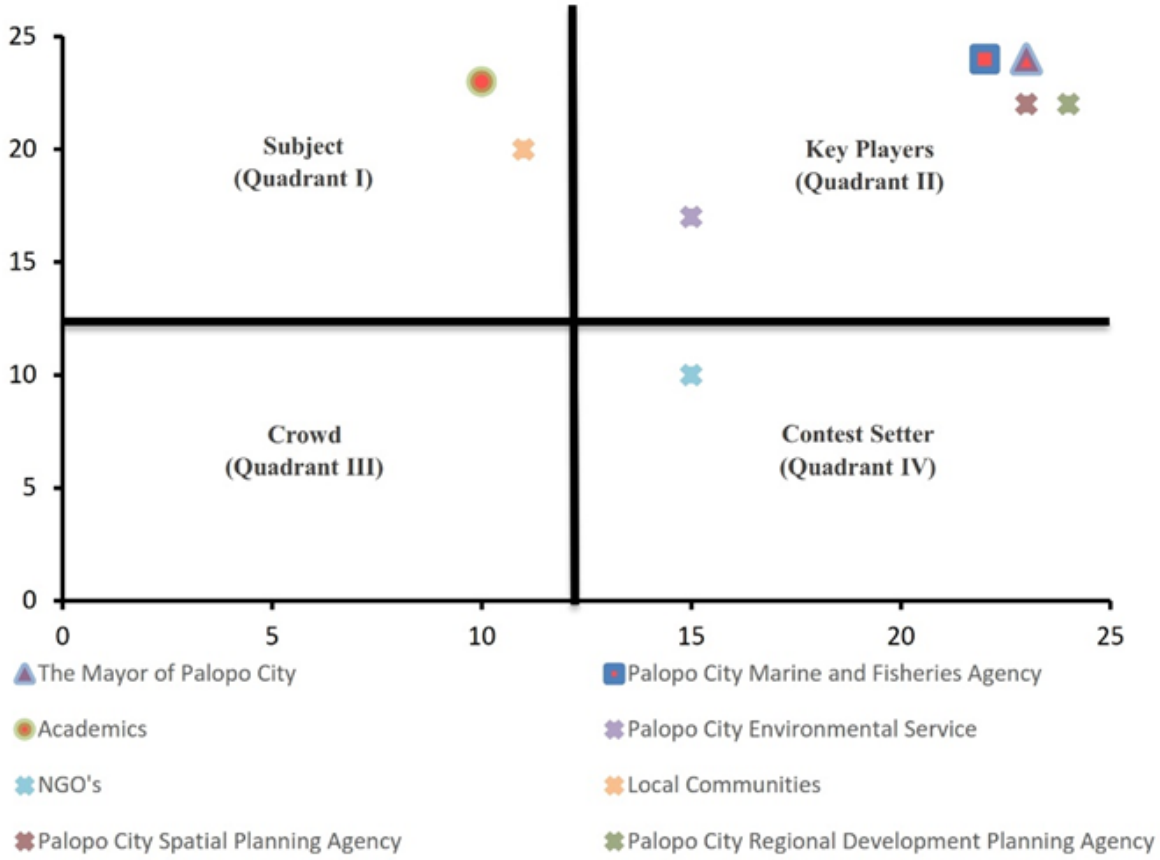

Figure 6. Classification of stakeholders according to the degree of influence and interests
Source: Primary data, (2020)

2) Stakeholders: *Contest Setter*

Contest setter category consists of actors or stakeholders who have litte interest but high influence (power). Stakeholders who are included in the Group of actors are non-governmental organizations. This category of stakeholders can pose risk, which is why their existence should be monitored with caution (Wang, Aenis, and Siew 2019); (Reed et al. 2009). Enhancing the effectiveness of the various roles stakeholders play, it is necessary to coordinate policy process with them (Oktavia and Saharuddin 2013); (Rahmawati, Noor, and Wanusmawatie 2014).

3) Stakeholders: *Subject*

Subject category are stakeholders who have high interest but little power with respect to a certain policy. This category of stakeholders are more likely to become recipients of the impact of the activity thay actively involved in the policy process. Thus, special initiatives are needed to entice their involvement into the policy or activity. Nonetheless, subject stakeholders can be influential in determing the effectiveness of the policy. This occurs if subject stakeholder's forge collaboration or coordination with other stakeholders

4. Strategy for managing coral reef ecosystems in Palopo City Waters

A strategy for managing coral reef ecosystems sustainably is one that fosters and supports functioning capacity of coral reef ecosystems by preventing sources of damage to it, thereby generating benefits for human life today and for future generations (Dahuri 2001). Acheving that feat requires management of coral reef ecosystems that is participatory, as well as prioritizing sustainable use of coral reefs.

a. Criteria for priority management of coral reefs in Palopo City waters

Various criteria can influence the management of coral reef ecosystems. Therefore, management strategy adopted to improve coral reef sustainability should take into consideration ecological, economic, social, and institutional conditions/criteria. Based on result of the hierarchy process analysis (AHP) of the four criteria related to the management of coral reef ecosystems, in descending order of importance in terms of level of significance are ecological conditions (0.543), social (0.270), economic (0.121), and institutional (0.063) criteria. Figure 7 depicts in coral reef management.

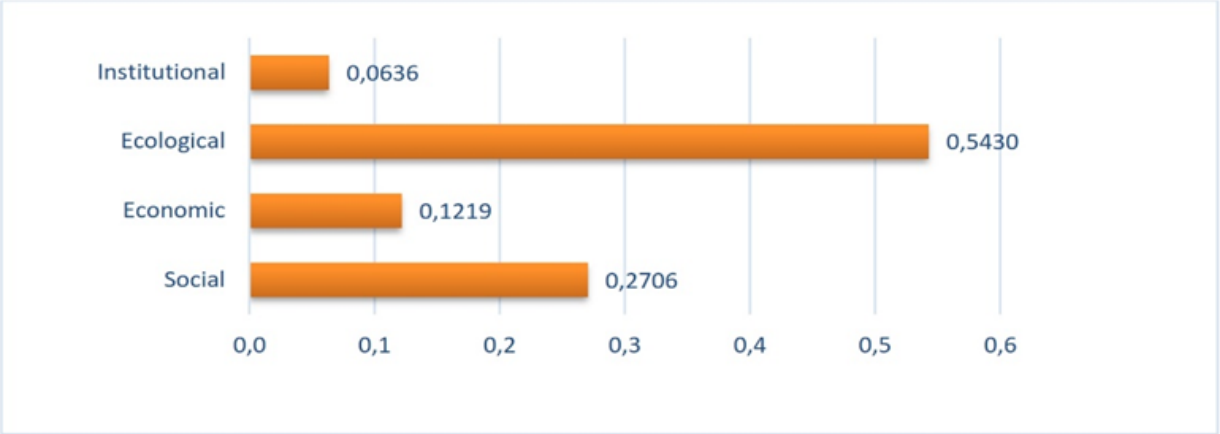

Figure 7. Criteria for priority management of coral reef ecosystems in Palopo City waters
Source: Primary data, (2020).

Based on pairwise comparisons, the first priority are ecological conditions/ criteria. The formulation of a coral reef ecosystem management strategy in this study considers sensitive attributes of ecological conditions/criteria, including water quality, percentage of live coral cover, coral fish diversity, and level of coral fish exploitation. Improving ecological conditions can be made by improving/maintaining water quality, increasing the percentage of coral cover at stations that have been damaged, and limiting the exploitation of reef fish by the community. Social conditions/criteria are the second priority in the management of coral reef ecosystems in Palopo City waters. Social criteria include alternative livelihoods, potential conflicts, and environmental knowledge.

Conditions in the research location indicate that there are not many

alternative livelihoods for the local community as most take out a living as fisherfolks. This had led to conflicts in the utilization of fishery resources. Besides, overdependence on fishing, has led to the overexploitation of resources, which in turn has increased damage to coral reef ecosystems.

Economic conditions/criteria are the third priority in the formulation of a strategy for managing coral reef ecosystems in Palopo City waters. Economic criteria include dependence on fisheries, fishing intensity, and capital availability. Over dependence of the community of the population in west Wara subdistrict on fisheries as the primary source of livelihood had contributed to overfishing of fisheries resources in local waters. Meanwhile, shortage of capital/finance to support the adoption of modern fishing methods, has meant that local communitu continue to fish in relatively shallow waters where which is the habitat for many coral reefs. Consequently, damage to coral reef ecosystem has been unavoidable. Finally, are the institutional criteria in the formulation of a coral reef ecosystem management strategy. Institutional criteria include environment outreach, level of community compliance, implementation, monitoring, and supervision. Based on result of conditions in the research location, damage to coral reef ecosystems is attributable to community activities that exploit fisheries resources using methods and tools that environmentally destructive, such as fishing using bombs and potassium. Such activities have undermined coral reef ecosystem sustainability.

b. Priority Strategies for Management of Coral Reef Ecosystems in Palopo City Waters

Based on result of coral reef ecosystems priority management analysis, which was conducted using expert choice software, the first strategic priority is the zoning of coastal and marine areas (0.396), followed by improving e coordination among stakeholders (0.304), preparation of regional regulations on coral reef ecosystems (0.195), and providing e training to the local community fishersfolks (0.105).

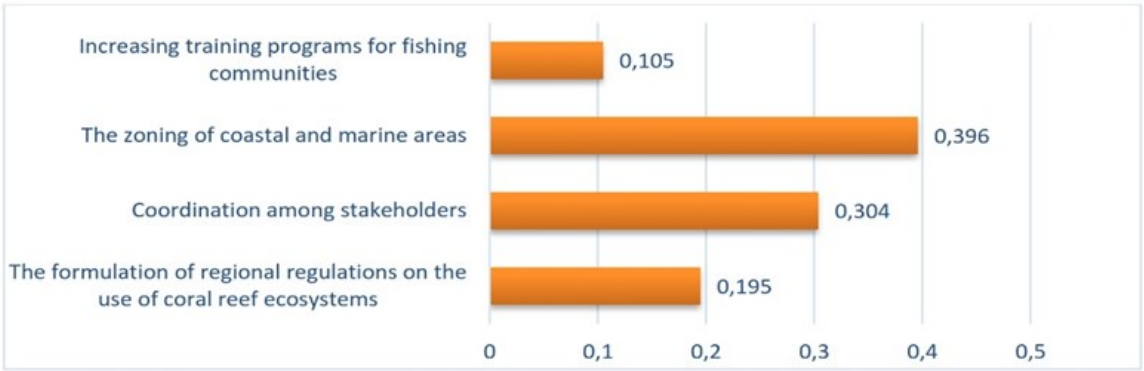

Figure 8. Priority strategies for managing coral reef ecosystems in Palopo City waters
Source: Primary data, (2020)

Priority strategies for managing coral reef ecosystem resources in Palopo City waters.

1) The zoning of coastal and marine areas.

Coral reefs ecosystems management Palopo City waters should be based on a zoning system. The zoning of coastal and marine areas should aim to restore damaged coral reef ecosystems. In principle, a mapping plan of the coastal area needed prior to formulating the recovery strategy and determining recovery priorities. There is need to have a needed as a first step. The zoning of coastal and marine areas can be based on fishing, marine cultivation areas, floating net cages and conservation zones, and other ways in accordance with needs/ utilization of each area. To prevent future conflicts over zone use, there should a buffer area that separates each zone. Restoration of coral reef ecosystems can be done gaining access to conservation zone, which should be free from disruption and disturbances from other activities. Such conditions foster natural growth and recovery of coral reefs ecosystems. Based on previous research, zoning of coastal and marine areas aims to separate the use of conflicting resources and determine prohibited and permitted activities aimed at each designated zone (Winanro and Suparno 2008); (Anggraini 2006).

2) Coordination among stakeholders.

Coordination among stakeholders is essential in the management of coral reef ecosystems in Palopo City waters. Effective coordination of stakeholders, can lead to the formulation and implementation of the policy that addresses the problem. Fishersfolks are some of the stakeholders to which attention must be paid if effective coral reef ecosystems management is to be achieved. Fisherfolks play a crucial role in maintaining the sustainability of the management of coral reef ecosystems. Thus, there is need for good coordination between fisherfolks and the government as well as with other actors involved in coral reef ecosystems management in Palopo City waters. The above finding is in line with previous research that showed that good coordination between stakeholders improves the prospects of achieving natural resource management objectives and enhances local community benefits (Cárcamo, Garay-Flühmann, and Gaymer 2014).

3) The formulation of regional regulations on the use of coral reef ecosystems.

The implementation of conservation activities requires enforcement by law and order authorities. To that end, the support of local government for conservation activities is crucial for their success. Without a clear legal basis, the implementation of conservation activities is likely to face various obstacles and problem. Statutory regulations exist as an legal umbrella in the management, preservation, and protection of coastal ecosystems (Batista, Pereira, and Botero 2019). Thus local government Palopo

City administration can play an active role in supporting conservation efforts by drafting local regulations that require the sustainable use of resources within and in the vicinity of coral reef ecosystems.

4) Increasing training programs for fishing communities.

The fishing community should have sufficient knowledge about the use of coral reef ecosystems (Peranginangin 2014). Acquisition of relevant and sufficient knowledge on sustainable fishing, importance of coral reefs for livelihood of fisherfolks and the environment, among other factors, should enhance understanding and support for coral reef ecosystem sustainability. Besides, the benefits of knowledge based community activities, can be enjoyed by both current and future generations. Previous research corroborates the importance of coastal community empowerment program through enhanced knowledge acquisition in improving the quality of the exploitation of natural resources and community welfare (Abrar et al. 2015).

CONCLUSION

Results of the identification exercise of causes of causes of coral reef damage, underscored the important role that overexploitation of local sea waters using destructive fishing methods has played in causing serious damage to coral reef in Palopo City waters. The highest level of damage to coral reefs was at station 1 with a depth of 4 meters, where the coral mortality index was 82.07%, and the lowest damage was at station 2 at a, depth of 4 meters which recorded coral, mortality index rate of 69.73%. As regards the level of interest and influence of stakeholders in the management of coral reef ecosystems, stakeholders were categorized into three groups that included, (1) the key player group stakeholders is a with high interest and power in the coral reef policy management comprised; the Palopo City mayor, Palopo City Marine and Fisheries affairs Agency, the Palopo City Regional Development Planning Agency, the Palopo City Spatial Planning Service Agency, and the Palopo City Environmental Agency; (2) subject group stakeholders, which is characterized by having high level of interest but low influence (power), and consisted of local communities and members of academics; and (3) contest setter stakeholder group that is characterized by low interest but high influence (power) in the coral reefs ecosystems policy management that included non-governmental organizations. Meanwhile, based on policy priorities, the strategy of zoning of coastal areas was identified as the first priority in the management of coral reef ecosystems in the waters of Palopo City, followed by formulating and implementing coordination among stakeholders on issues that relate to the management of coral reef ecosystems; third strategy entails preparation and enacting local regulations that require and enforce sustainanble use of coral reef ecosystems; and lastly enchacing

training programs for the fishing community.

ACKNOWLEDGEMENTS

The author would like to thank the Ministry of Research, Technology, and Higher Education's for the 2020 research grant and Head of the Palopo City Marine Fisheries Service.

REFERENCES

Abrar, Muhammad, Muhammad Adrim, Pramudji, Muhmmad Husni Askab, Muhammad Hafizt, Selvi Octaviany, Samsuardi, Hendri Guswanto, M. Yusuf Amrullah, Asep Rasyidin, LH Purnomo, and Riris Hermawan. 2015. *Monitoring Kesehatan Terumbu Karang Dan Ekosistem Terkait Di Taman Wisata Perairan (Twp) Selat Bunga Laut, Kabupaten Kepulauan Mentawai, Sumatera Barat*.

Almutairi, Ayedh, Zachary A Collier, Daniel Hendrickson, Jose M Palma-Oliveira, Thomas L Polmateer, and James H Lambert. 2018. "Stakeholder Mapping and Disruption Scenarios with Application to Resilience of a Container Port Manuscript." *Reliability Engineering and System Safety*. doi: 10.1016/j.ress.2018.10.010.

Anggraini, Oktiva. 2006. "Kajian Restropektif Program Pemberdayaan Ekonomi Masyarakat Pesisir." *JKAP (Jurnal Kebijakan Dan Administrasi Publik)* 10(Mei):19–34.

Anon. 2018. *Dinas Kelautan Dan Perikanan Kota Palopo*.

Anon. 2020. "Portal Resmi Pemerintah Kota Palopo." Retrieved September 19, 2020 (https://www.palopokota.go.id/).

Batista, Celene Milanés, Cristina I. Pereira, and Camilo M. Botero. 2019. "Improving a Decree Law about Coastal Zone Management in a Small Island Developing State: The Case of Cuba." *Marine Policy* 101(March 2018):93–107. doi: 10.1016/j.marpol.2018.12.030.

Bibin, Muhammad, Yon Vitner, and Zulhamsyah Imran. 2018. "Analysis of Stakeholder in the Development of Labombo Beach Sustainable Town in Palopo City." *Masyarakat, Kebudayaan Dan Politik* 31(1):62–71. doi: http://dx.doi.org/10.20473/mkp.V31I12018.62-71.

Cárcamo, P. Francisco, Rosa Garay-Flühmann, and Carlos F. Gaymer. 2014. "Collaboration and Knowledge Networks in Coastal Resources Management: How Critical Stakeholders Interact for Multiple-Use Marine Protected Area Implementation." *Ocean and Coastal Management* 91:5–16. doi: 10.1016/j.ocecoaman.2014.01.007.

Chang, Y. C., F. W. Hong, and M. T. Lee. 2008. "A System Dynamic Based DSS for Sustainable Coral Reef Management in Kenting Coastal Zone, Taiwan." *Ecological Modelling* 211(1–2):153–68. doi: 10.1016/j.ecolmodel.2007.09.001.

Crosby, M. P., G. Brighouse, and M. Pichon. 2002. "Priorities and Strategies for Addressing Natural and Anthropogenic Threats to Coral Reefs in Pacific Island Nations." *Ocean and Coastal Management* 45(2–3):121–37. doi: 10.1016/S0964-5691(02)00051-0.

Dahuri, Rokhimin. 2001. "Pengelolaan Ruang Wilayah Pesisir Dan Lautan Seiring Dengan Pelaksanaan Otonomi Daerah." *Jurnal Sosial Dan Pembangunan* 17(2):139–71. doi: https://doi.org/10.29313/mimbar.v17i2.38.

Estradivari, Handayani, Et. a. 2017. "Kawasan Konservasi Perairan." *WWF Jakarta Indonesia*.

Kohler, Kevin E., and Shaun M. Gill. 2006. "Coral Point Count with Excel Extensions (CPCe): A Visual Basic Program for the Determination of Coral and Substrate Coverage Using Random Point Count Methodology." *Computers and Geosciences* 32(9):1259–69. doi: 10.1016/j.cageo.2005.11.009.

Lu, Chao, Hu-chen Liu, Jie Tao, Ke Rong, and Ying-che Hsieh. 2017. "Technological Forecasting & Social Change A Key Stakeholder-Based Fi

Nancial Subsidy Stimulation for Chinese EV Industrialization : A System Dynamics Simulation." *Technological Forecasting & Social Change*. doi: 10.1016/ j.techfore.2017.01.022.

Maxwell, R. J., and R. Filgueira. 2020. "Key Players in the Grieg NL Placentia Bay Atlantic Salmon Aquaculture Project : A Social Network Analysis." *Marine Policy* 113:103800. doi: 10.1016/ j.marpol.2019.103800.

MENLH. 2001. *Keputusan Menteri Negara Lingkungan Hidup Nomor 4 Tahun 2001 Tentang Kriteria Baku Kerusakan Terumbu Karang*.

Muzani. 2014. "Strategi Peningkatan Peran Stakeholder Dalam Pengelolaan Mangrove Di Kabupaten Tangerang." *Spatial Wahana Komunikasi Dan Informasi Geografi* 112(2).

Nybakken, James W. 1988. *Biologi Laut : Suatu Pendekatan Ekologis*. Jakarta: Gramedia.

Oktavia, Siska, and Saharuddin. 2013. "Hubungan Peran Stakeholders Dengan Partisipasi Masyarakat Dalam Program Agropolitan Desa Karacak Kecamatan Leuwiliang Kabupaten Bogor." *Jurnal Sosiologi Pedesaan* 01(03):231–46.

Peranginangin, Lily Sri Ulina. 2014. "Partisipasi Masyarakat Dalam Pengelolaan Kawasan Konservasi." *JKAP (Jurnal Kebijakan Dan Administrasi Publik)* 18(1):66–78. doi: 10.22146/jkap.6877.

Rahmawati, Triana, Irwan Noor, and Ike Wanusmawatie. 2014. "Sinergitas Stakeholders Dalam Inovasi Daerah (Studi Pada Program Seminggu Di Kota Probolinggo)." *Jurnal Administrasi Publik* 2(4):641–47.

Reed, Mark S., Anil Graves, Norman Dandy, Helena Posthumus, Klaus Hubacek, Joe Morris, Christina Prell, Claire H. Quinn, and Lindsay C. Stringer. 2009. "Who's in and Why ? A Typology of Stakeholder Analysis Methods for Natural Resource Management." *Journal of Environmental Management* 90 (5):1933–49. doi: 10.1016/ j.jenvman.2009.01.001.

Saphier, Adam D., and Tegan C. Hoffmann. 2005. "Forecasting Models to Quantify Three Anthropogenic Stresses on Coral Reefs from Marine Recreation: Anchor Damage, Diver Contact and Copper Emission from Antifouling Paint." *Marine Pollution Bulletin* 51(5–7):590–98. doi: 10.1016/ j.marpolbul.2005.02.033.

Singgalen, Yerik Afrianto, Pamerdi Giri Wiloso, and Gatot Sasongko. 2017. "Evaluation of the Implementation of Tourism Policy." *JKAP (Jurnal Kebijakan Dan Administrasi Publik)* 21 (1):76–98. doi: 10.22146/jkap.16751.

Soerjono, Soekanto. 2004. *Sosiologi Suatu Pengantar*. Jakarta: Raja Grafindo Persada.

Sunahwati, Eka, Muhammad Syamsul Maarif, and Anggraini Sukmawati. 2019. "Human Resources Development Policy as a Strategy for Improving Public Organizational Performance." *JKAP (Jurnal Kebijakan Dan Administrasi Publik)* 23(1):50–62. doi: 10.22146/jkap.37957.

Tomascik, T., A. J. Mah, A. Nontji, and M. K. Moosa. 1997. *Chapter Eighteen: Seagrasses. In The Ecology of the Indonesia Seas, Part II*. Singapore: Periplus Editions (HK) Ltd.

Tuwo, Ambo. 2011. *Pengelolaan Ekowisata Pesisir Dan Laut (Pendekatan Ekologi, Sosial-Ekonomi, Kelembagaan Dan Sarana Wilayah*. Sidoarjo: Brilian Internasional.

Valderrama Ballesteros, Laura, Jennifer L. Matthews, and Bert W. Hoeksema. 2018. "Pollution and Coral Damage Caused by Derelict Fishing Gear on Coral Reefs around Koh Tao, Gulf of Thailand." *Marine Pollution Bulletin* 135(March):1107–16. doi: 10.1016/ j.marpolbul.2018.08.033.

Wang, Jue, Thomas Aenis, and Tuck Fatt Siew. 2019. "Communication Processes in Intercultural Transdisciplinary Research: Framework From a Group Perspective." *Sustainability Science* 14 (6):1673–84. doi: 10.1007/s11625-019-00661-4.

Webler, Thomas, and Karin Jakubowski. 2016. "Mitigating Damaging Behaviors of Snorkelers to Coral Reefs in Puerto Rico Through a Pre-Trip Media-Based

Intervention." *Biological Conservation* 197:223–28. doi: 10.1016/ j.biocon.2016.03.012.

Winanro, Tjahjo, and Suparno. 2008. "Kajian Kondisi Terumbu Karang Dan Strategi Pengelolaannya Di Suaka Pesisir Batang Gasan, Kabupaten Padang Pariaman, Sumatera Barat." *Sains Akuatik* 13(2):17–30.

Yehong, Li, James O Donnell, Raul Garcia Castro, and Sergio Vega Sanchez. 2017. "Identifying Stakeholders and Key Performance Indicators for District and Building Energy Performance Analysis." *ENB*. doi: 10.1016/ j.enbuild.2017.09.003.

Yulianda, Fredinan, Achmad Fahruddin, Luky Adrianto, Armin Ambrosius Hutabarat, Sri Harteti, Kusharjani, and Ho Sang Kang. 2010. *Kebijakan Konservasi Perairan Laut Dan Nilai Valuasi Ekonomi*. Bogor: IPB Press.

Yulika Sari, T. Ersti, and Usman. 2012. "Studi Parameter Fisika Dan Kimia Daerah Penangkapan Ikan Perairan Selat Asam Kabupaten Kepulauan Meranti Provinsi Riau." *Jurnal Perikanan Dan Kelautan* 17(1):88–100.