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Development on The Fishermen's Resilience Index Modeling in Indonesia

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ABSTRACT

The fishermen's resilience index modeling was prepared as an effort to develop a fishermen's resilience assessment model based on a social ecological system approach. Fishermen have various kinds of obstacles in order to maintain their lives and livelihoods so that they are able to provide adequate catch for their welfare. Therefore, it is necessary to develop an index model that can demonstrate their resilience to the various problems they face. The fishermen's resilience index is composed of five composite indexes, namely: (1) Socio-ecological index (ISE), (2) ecological-economic index (IEE), (3) socio-institutional index (ISI), (4) social-index infrastructure (ISF) and (5) Social-safety index (ISH). The Value of Fishermen Endurance Index (IKN) ranges from 0 - 1. The value of IKN is getting closer to value 1, then the resilience of fishermen can be said to be near perfect (very good).

1. INTRODUCTION

Indonesia has a wide range of coastal and marine ecological characteristics and very high fisheries resources which have an impact on the diverse character of ecosystem and resource use (Wahyudin et al., 2016, 2018; Wahyudin, 2017). This further provides diversity in social and cultural characteristics related to ecological and coastal and marine resource use, including fishery resources (Wahyudin, 2003). The diversity of social and cultural characteristics as a whole has an impact on the economic system of coastal areas that tend to be very dependent on the availability of surrounding resources (Paulangan et al., 2019; Wahyudin et al., 2019).

Existing fisheries activities around the coastal and marine areas have an impact on the economy and regional development (Wahyudin, 2016). Fishery activities carried out by fishermen are very vulnerable to ecological, social, economic, cultural, political and security conditions, so that mitigation efforts are needed so that the vulnerability of fishermen can be minimized (Kusumastanto and Wahyudin, 2012). Therefore, a study of fishermen resilience in Indonesia needs to be done.

This study must at least be able to map the factors that influence the existence of fishermen's resilience, so that it can be predicted the tendency of its resilience index and in turn can be used as a basis for recommending priority-level vulnerable policies so that the policies that are rolled out can be of productive value, on target and gradual from the most vulnerable to the most resistant to the maximum benefits and welfare of Indonesian fishermen.

The purpose of the Study of Determination of Fishermen's Resilience Index in Indonesia is to identify factors that influence the level of fishermen's resilience, compile an algorithm of fishermen's resilience index, formulate methods

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for determining fishermen's resilience index, and formulate follow-up recommendations.

2. RESILIENCE AND SOCIAL ECOLOGICAL SYSTEM OF MARINE AND FISHERIES

2.1. Resilience and Vulnerability

Wahyudin (2013) argues that environmental risks can be caused by (1) natural disasters, (2) disasters caused by human activity and (3) complex emergencies. Environmental risks due to natural disasters include (i) disasters due to geological factors (earthquakes, tsunamis and volcanic eruptions), (ii) disasters caused by hydrometeorology (floods, landslides, droughts, hurricanes), (iii) disasters due to biological factors (outbreaks of human diseases, plant/livestock diseases, plant pests), and (iv) technological failures (industrial accidents, transportation accidents, nuclear radiation, chemical pollution).

Wahyudin (2013) further states that disasters caused by human activities are usually related to conflicts between people, including (i) due to the struggle for limited resources and (ii) ideological, religious and political reasons, whereas complex emergencies are a combination of disaster situations in an area conflict. The complexity of the disaster problem requires a careful arrangement or planning in its response, so that it can be carried out in a directed and integrated manner.

Sea environmental risk due to oil spills in this case can be categorized as environmental risk due to technology failure (Wahyudin, 2013; Mahipal and Wahyudin, 2019). Technology failure is a catastrophic event as a result of human design, operation, neglect and deliberate mistakes in the use of technology and/or industry. This type of disaster can cause casualties, air, water and soil pollution, as well as building damage, and other damage. In addition, this disaster on a large scale can threaten global ecological stability.

This environmental risk then becomes one of the vulnerability components for the coastal and marine ecological social system that is used as the basis for calculating the environmental sensitivity index. Vulnerability in this case is defined as the level of sensitivity of a resource to changes that occur, or in other words vulnerability (vulnerability) is a condition or nature / behavior of humans or society that causes the inability to face danger or threat (Wahyudin, 2013). The vulnerability in question can be sourced from physical, economic, social, and environmental characteristics. While resilience can be defined as the power of a resource to adapt to changes, both due to nature, and due to human activities.

2.2. Marine and Fisheries Social Ecological System

2.2.1. Ecosystem Services

Humans benefit from a variety of resources and processes provided by natural ecosystems (Wahyudin et al., 2016; Wahyudin, 2017; Yudi Wahyudin et al., 2018). Overall, these benefits are known as ecosystem services and include products such as drinking water and processes such as waste decomposition. Ecosystem services are goods or services provided by ecosystems for humans and become the basis for valuation of an ecosystem (Hein et al., 2006). The availability of ecosystem services often varies with time and their actual and potential future availability must be part of the assessment (de Groot et al., 2012; Costanza et al., 2014).

Understanding of ecosystem services is the benefits obtained by someone and the community both directly and indirectly from the existence of an ecosystem (Wahyudin, 2016). Integrated management of land, water, species diversity and biological resources that encourage conservation and sustainable use is the basis for maintaining ecosystem services, including those that play a role in disaster risk reduction (Millennium Ecosystem Assessment, 2013). MEA classifies ecosystem services into four groups namely production services, regulatory services, cultural services and supporting services (Wahyudin et al., 2016; Wahyudin, 2017). Ecosystems provide environmental services consisting of:

(i) Provisioning services, i.e. environmental services in providing such sources of food and natural medicines.
(ii) Regulatory services, namely environmental services in regulating and maintaining such as air quality, climate regulation, water regulation and erosion control.
(iii) Cultural services, namely environmental services related to cultural identity and

diversity, religious and spiritual values, knowledge (traditional and formal), inspiration and aesthetic values, social relations, heritage values, recreation, etc. etc.

(iv) Supporting services, namely environmental services in supporting the production of key products such as nutrients.

2.2.2. Social Ecological System

The socio-ecological system reflects the existence of a very close integration between humans (social systems) and nature (ecological systems) (Cumming, 2011). The key to the socio-ecological system is the cooperative aspect, where individuals who have some resources are invested in several types of physical or institutional infrastructure. The socio-ecological system according to Carpenter and Folke (2006) in Adrianto (2009) defines the social ecological system as an integrated system of nature and society with reciprocal feedbacks. Meanwhile, according to Anderies et al. (2004) states that the social-ecological system is an ecological system that is closely related and influenced by one or more social systems. Social and ecological systems contain interdependent units and interact with each other involving various subsystems.

The concept of socio-ecological system shows the existence of utilization by the social system to the ecological system. When there is an utilization of a natural resource, management is absolutely necessary related to the use and preservation of resources. This aims to maintain the sustainability of natural resources and their use by social systems. This management aims to prevent the loss of natural resources (ecological systems) which are likely to be the cause of the collapse of related social systems. The complexity of the socio-ecological system requires a management strategy that is ready to answer the riddle of the system, namely adaptive management (Arkham, 2015).

Coastal and marine ecosystems as a form of one of the ecological systems are often forgotten in the management of coastal resources. Its existence which was once underestimated has now begun to be noticed with the development of science, including concepts that do not consider each resource as a single individual but as a coastal compiler. Coastal ecosystems also have an important role in providing a good source of protein for the community. The Zanzibar Region, Tanzania coastal communities collect invertebrate animals from seagrass beds in the tidal zone to meet daily needs. A full picture of this system needs to be known, it must see the coastal ecosystem as part of a socio-ecological system. It can be understood that the human element and seagrass elements will change together in accordance with the rules of pairing in the social-ecological framework (coupled socio-ecological framework) (Cullen-Unsworth et al., 2013).

Coastal ecosystems which are part of an ecological system that is able to influence and be influenced by social systems, in this case the people who live around the coastal ecosystems. Coastal ecosystems that have a function as a place for fish habitat or provisioning services are the main land for fishermen to extract and exploit fishery resources, so as to form a social system where fishermen depend on the existence of coastal ecosystems (Arkham, 2015). The collapse of a socio-ecological system (SSE) can only occur when the social system and the ecological system that are linked together collapse (Anderies et al., 2004). The relationship between social systems and ecological systems can be used as a material and concept in managing sustainable fisheries.

2.2.3. Social-Ecological Connectivity

The system-ecological component and the interaction of both in fisheries is one of a complex system. According to Parsram (2008) states in Granada and St. Lucia in a complex system explains that there is connectivity between social systems and ecological systems. There are fishing activities, fish landing and marketing of catches from the use of fisheries resources for large pelagic and shallow reef fish in small scale fisheries. In the management of small-scale fisheries sustainability by stakeholders, attention must be paid to how the socio-ecological system as one of the complex systems is related to the connectivity between the two components. Arkham (2015) also explained that social-ecological system connectivity is very important to know in sustainable fisheries management. This is explained because the use of an ecological system if not balanced with the preservation of resources (conservation) will cause damage to the coastal ecosystem. Changes in the ecological system will affect the social system, and vice versa.

One example in the context of coastal ecosystem management, the connectivity of the socio-ecological system is very important considering the characteristics and dynamics of coastal ecosystems are interrelated dynamics between natural systems and human systems so that the two main systems making up seagrass areas move dynamically in a magnitude similarity (magnitude) . His view that the two systems are inseparably and dynamically interrelated so that knowledge integration is needed in the implementation of integrated coastal ecosystem management (Cumming et al., 2011).

The concept of SES connectivity according to Davidson-Hunt and Barker (2003) explains that a good relationship from the nature of social systems, ecological systems, or from a mixture of both can provide an interrelation and dependence both from the ecological component or from the social component. The activities of humans can make connectivity with the ecological system, so that a social-ecological network system that can influence each other can occur. Social systems can occur in connectivity with ecological systems in coastal areas, especially through small-scale fishing activities that utilize large pelagic fisheries resources and shallow reef fishes in the Eastern Caribbean and the results of research by Torre-Castro et al. (2014) concerning the use of fisheries resources associated with seagrass ecosystems by small scale fisheries such as those in Tanzania.

Adopting Anderies et al. (2004), the SSE framework for coastal and marine ecosystems consists of 4 components, namely (A) the components of coastal and marine ecosystem resources; (B) components of resource users, (C) components of infrastructure for coastal and marine resources; and (D) coastal and marine resource infrastructure components. Component A is a component of coastal and marine ecosystem resources used by several coastal and marine ecosystem resource users (B). Components B and C, namely users of coastal and marine ecosystem resources and infrastructure providers of coastal and marine ecosystem resources, are components consisting of humans (human). Individuals in components B and C sometimes overlap or are totally different depending on the structure of the social system that governs and manages the socio-ecological system. While component D, infrastructure of coastal and marine ecosystem resources which combines two forms of human-made capital in the form of physical and social capital. Diagramatically, the relationships between the 4 (four) components are presented in Figure 1 below.

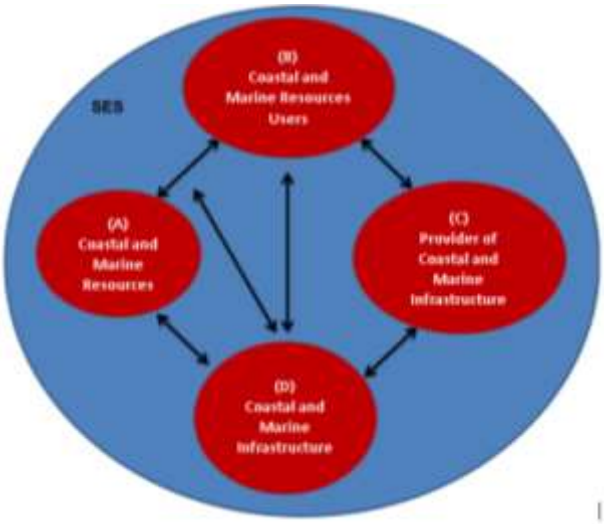

Figure 1. Conceptual Model of Social-Ecological Systems in Coastal and Marine Ecosystems (Modifications from Anderies et al., 2004)

Human activities can create social-ecological networks by connecting ecological processes so that free ecological systems become connected by human activities. One example is where fishermen who fish in different lakes will transfer invasive species by boat that is transported from one lake to another lake, of course the lake becomes ecologically connected. On the other hand social relations can be created through ecological relations, such as rivers that connect people from upstream to downstream (Damayanti, 2011).

2.2.4. Small Scale Fisheries (SSF) Characteristic

As stated in the previous reference that the classification of small or large scale fisheries, inshore or offshore fisheries, artisanal or commercial until now is still being debated given its broad dimensions. The grouping can be based on the size of the ship or the amount of power, the type of fishing gear, and the distance of the fishing area from the coast (Wahyudin, 2011; Kusumastanto and Wahyudin, 2012).

According to Charles (2001) states that the scale of fishing businesses can be seen from various aspects, including based on the size of the ship being operated, based on the fishing area, namely the distance from the coast to the location of

capture and based on the purpose of production. The grouping is done through the comparison of small-scale fisheries with large-scale fisheries, although it is not yet clear, so it still needs to be seen from various more specific aspects. More specifically the characteristics of small-scale fisheries revealed by Smith (1983) states that the scale of fisheries business can be seen by comparing fisheries based on the techno-socio-economic situation of fishermen and dividing them into two large groups namely industrial and traditional fishermen.

Small scale fisheries in Indonesia are the biggest contributor to fisheries production. Most of the laborers engaged in the fishing sector are still traditional fishermen and very far behind those of other countries. He further said that one of the strategic points of the main causes of poverty and helplessness of fishermen is the weak ability of business management. This also happens because of the low education and mastery of fisheries skills. Therefore empowering marine fisheries resources should be done through approaches with fishermen, among others by empowering small fishing groups so that they can organize their business activities (Arkham, 2015).

Traditional fishing according to Barkes et al. (2001) are those which have the following characteristics:

(i) Activities carried out with small-scale fishing units, sometimes using motorized boats or none at all.
(ii) Arrest activities are part-time, and family income is sometimes added from other income from activities other than arrest.
(iii) Ships and fishing gears are usually self-operated.
(iv) Fishing gear is self-made and operated without the aid of a machine.
(v) Low investment with loan capital and catchment catch.
(vi) Catches per business unit and productivity at moderate to very low levels.
(vii) Catches are not sold to large markets organized by baiuk but are circulated at landing sites or sold at sea and are usually consumed alone with their families.
(viii) Traditional fishing communities are often geographically and socially isolated with a low standard of living for fishing families.

Knowledge about the dynamics of the fisheries system can be used to answer the problem of changes and variations in the components of each time in the fisheries system and the interaction between components within it. The time factor becomes very important because it becomes a determining factor in the dynamics of a fisheries system. Time scale according to Charles (2001) states can be divided into 5 (five), namely: 1) daily to weekly, 2) monthly to season, 3) annual, 4) between years, and 5) decades (decades) or longer.

2.3. Resilience Index

2.3.1. Dependence of Small-Scale Fisheries on Marine and Coastal Ecological System

Coastal communities generally depend their lives on resources in coastal ecosystems (Wahyudin et al., 2016; Adrianto et al., 2017; Wahyudin, 2017). This dependence can lead to overexploitation, which can make coastal ecosystems degraded. How much the dependence of coastal communities on ecosystems can be measured using livelihoods at the level of a fisherman's household (Anggraeni, 2015). Ferrol-shulte et al. (2013) confirms that the approach is still suitable to be applied in measuring the dependence of coastal communities on coastal and marine resources in a coastal socio-ecological system, so that this livelihoods approach will be used in measuring the extent of the dependence of coastal communities on seagrass ecosystems with certain indicators .

The method used was in-depth interviews using semi-structured questionnaires and fishermen household participation approaches, the amount of which was determined by simple random sampling, and several key respondents (village heads, fishermen group heads, organization heads, and other important figures) with using snowball sampling, where interviewees recommend the next prospective respondent (Cullen-Unsworth et al. 2013; Ferrol-Shulte et al. 2013; Forster et al. 2014). The use of the snowball sampling method aims to interview fishermen as respondents, not fishermen who operate on a larger scale. Questions were asked at the interview regarding demographics, livelihoods, reasons for choosing work and alternative work (Arkham et al., 2018; Paulangan et al., 2018). Literature study was also conducted to complement the results of the interview. Data from the interviews obtained were

analyzed using the open coding method (Forster et al. 2014). Open coding method is a way of presenting interview data by grouping respondents' answers based on the similarity of the answers. This aims to explore respondents' diverse answers (not fixated on the choice of answers provided by the interviewer), so that more information is obtained. Generally, this method is used to present data from the results of interviews using a semi-structured questionnaire.

2.3.2. Identification of Social-Ecological System Resilience Factors

Two aspects are used in identifying SES resilience factors, namely ecological and socio-economic aspects, in this case Anggraeni (2015) takes the case of its association with seagrass ecosystem systems. Ecological aspects include the composition of seagrass species, susceptibility to phase changes, seagrass seed reserves, seagrass recovery, seagrass habitat health, macroalgae cover, identification of eutrophication seagrass closure trends. Furthermore, all indicators were scored to determine the level of seagrass ecological resilience. Detail scoring from each ecological indicators and criteria could be shown in Table 1.

The criterion for dependence on seagrass resources in this study is a modification of the criteria compiled by Marshall et al. (2007). The criteria that originally amounted to 10 were found to be 9 criteria for dependence on biological resources. Social dependence includes four criteria: occupational attachment, attachment to place, employability, family characteristics. The economic dependence includes business size and financial condition. Whereas environmental dependency covers the level of specialization, duration of fishing (time spent harvesting) and interest and knowledge of the environment. Indicators of social resilience include dependence on resources, flexibility of fishing households, income and employment alternatives (Marshall and Marshall, 2007) for socio-ecological resilience, indicators of environmental awareness and the role of institutions need to be added (Schwarx et al. 2011; Cullen-unsworth et al. 2013; Forster et al. 2014).

Questions asked related to interviews include; the size of fishermen households, livelihood strategies, perceptions and readiness of fisheries households to face disruption or disaster, the level of togetherness of coastal communities, institutions and their roles (formal, non-formal) as well as reciprocity of fishing households towards seagrass ecosystems. The following are the criteria used to see social resilience carried out by Anggraeni (2015). Detail scoring from each social indicators and criteria could be shown in Table 2.

3. MODELING OF FISHERMEN'S RESILIENCE INDEX

3.1. Social-Ecological System Approach

In this study, the resilience index is a value that indicates the magnitude of fishermen (resource users) in the face of changes that occur around them. Jansen and Anderies (2013) states that ecological changes are changes that are driven by changes in related ecosystems (7) that affect the availability of fisheries resources and can ecologically disturb the stability of public infrastructure, while social, economic and political changes (8) can also influence the existence of resource users (fishermen), in addition to influencing the policies and governance issued and run by public infrastructure providers. Therefore, fishermen's resilience index (FRI) can be formulated based on components within the framework of the social ecological system framework developed by Jansen and Anderies (2013) (Figure 2).

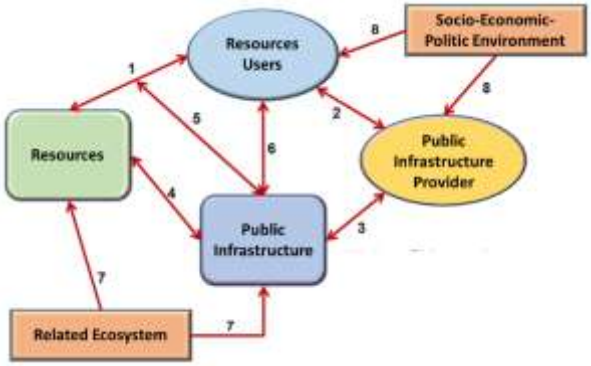

Figure 2. The framework of the linkages of the resilience index with the socio-ecological system infrastructure and all changes that affect it (Jansen and Anderies, 2013)

The index of resilience in this case is designed based on a value from 0-1. The closer to 1, the resilience of fishermen in the face of change can be said to be stronger and more perfect.

Table 1. Detail scoring from each ecological resillience indicators and criteria

Nr	Indicators of Seagrass Ecology Resilience	Criteria	Score
1	Composition of seagrass species	• 75% of seagrass species are slow growing and 25% of seagrass species are fast growing • 50% of seagrass species are slow growing and 50% of seagrass species are fast growing • 25% of seagrass species are slow growing and 75% of seagrass species are fast growing	1 2 3
2	Susceptibility to phase changes	• > 50% of total seagrass density • > 25% -50% of total seagrass density • <25% of total seagrass density	1 2 3
3	Seagrass seed reserves	• Only found at one sampling point • Only found at two sampling points • Found at three sampling points	1 2 3
4	Seagrass recovery (growth of rhizome)	• 1.75 - 3.65 cm / month • 3.61 - 5.45 cm / month • 5.46 - 7.30 cm / month	1 2 3
5	Seagrass habitat health (SHH)	• 0 < SHH ≥ 33,33 • 33,33 < SHH ≥ 66,66 • 66,66 < SHH ≥ 100	1 2 3
6	Macro-alga coverage	• > 50% of the maximum seagrass cover • > 25% - 50% of the maximum seagrass cover • < 25% of maximum seagrass cover	1 2 3
7	Eutrophication indication	• Nitrates and ortho phosphates exceed the eutrophication limit • Nitrates or ortho phosphates exceed the eutrophication limit • Nitrates and ortho phosphates do not exceed the eutrophication limit	1 2 3
8	Trend of seagrass area	• Decreasing • Reduced and / or fixed • Continue and / or increase	1 2 3

Sources: Anggraeni (2015).

Table 2. Detail scoring from each social resilience indicators and criteria

Nr	Indicators of Seagrass Social Resilience	Criteria	Score
1	Dependence on seagrass resources	• Dependency scores range between 19-27 • Dependency scores range between 10-18 • Dependency scores range between 1 - 9	1 2 3
2	The flexibility of fishing households	• Fishing family size ranges from 1-2 • Fishing family size ranges from 3 - 4 • Fishing family size > 4	1 2 3
3	Income	• Income below the poverty limit (2 US $ per day) • Income below the UMR Bintan limit (63,000 per day) • Income above the UMR Bintan (63,000 per day)	1 2 3
4	Alternative income	• Percentage of fishermen with alternative income ≤ 33.33% • Percentage of fishermen with alternative income ranges from 33.34 - 66.66% • Percentage of fishermen with alternative income > 66.66%	1 2 3

Sources: Anggraeni (2015).

3.2. Logical Framework Approach for Measuring Fishermen's Resilience Index

The Fishermen Endurance Index is approached with a social-ecological system approach framework as developed by Jansen and Anderies (2013) which consists of 4 (four) basic system components, namely resources (fish), resource users (fishermen), infrastructure, and infrastructure providers (government and / or other stakeholders). The four components of the system are influenced by (1) related ecosystems which in this case are and are limited by 11 fisheries management areas (WPP) and (2) socio-political and cultural conditions, both of which will be affected by the existence of policy-level priority mitigation performance (Figure 3).

$$FRI_i = \frac{1}{3}\left(\prod_{j=1,i=1}^{n,m} CI_{ji} \right)^{\frac{1}{n}}$$

Where,FRI_i is the Fishermen Resilience Index in a region-i, n is the number of indices used, CI_j is the composite index of j, j is (1) Socio-ecological index (SEI), (2) ecological-economic index (EEI), (3) socio-institutional index (SII), (4) socio-infrastructure index (SIfI) and (5) socio-security index (SSI). Each of index is arranged based on the geometric mean of several strategic parameters (SP) given a score of 1 - 3. Each index follows the following formula:

$$CI_j = \left(\prod_{k=1}^{n} SP_{jk} \right)^{\frac{1}{n}}$$

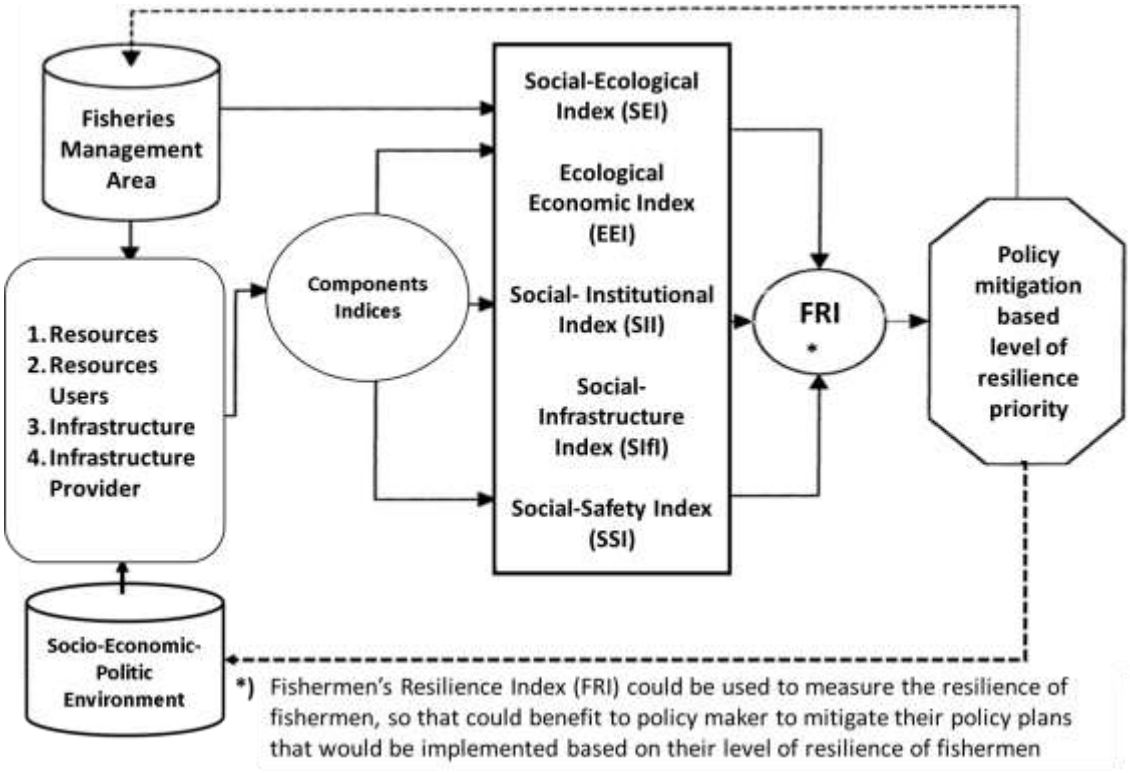

Figure 3. The approach framework for determining fishermen resilience index (FRI)

3.3. The Algorithm of Fishermen's Resilience Index (FRI)

Fisherman's Resilience Index (FRI) values range from 0-1 which states that the closer to the value of 1, then the resilience of fishermen can be said to be near perfect (very good). This index value is determined based on the index formula as follows:

Where, CI_j is the Composite Index of j, n is the number of strategic parameters (SP) used to compile the composite index of j, SP_k is the strategic parameter of k from the composite index of j, k is sub-indicator of SP of 1, 2, ..., n. Table 3 shows the components of each strategic parameter of the socio-ecological, ecological-economic, socio-institutional, socio-infrastructure, and socio-safety, meanwhile and Table 2 shows components of each strategic parameter and each of their indicators and their scoring.

Table 3. The components index and each strategic parameter

Nr	Index	Formula	Strategic Parameter (SP)
1	Socio-Ecology (SEI)	$SEI_j = \left(\prod_{k=1}^{n} CSEI_{jk} \right)^{\frac{1}{n}}$	1.1 Work time allocation
			1.2 Knowledge about sustainable resources
			1.3 The quality of coastal and marine resources
			1.4 Fishing ground
			1.5 The volume of harvest per trip per fishermen (fish stock abundance)
2	Ecological-Economics (EEI)	$EEI_j = \left(\prod_{k=1}^{n} CEEI_{jk} \right)^{\frac{1}{n}}$	2.1 The conflict of resources economic utilization
			2.2 The flexibility fishermen household
			2.3 Fishermen income
			2.4 The availability of alternative income
			2.5 Degree of independence business (property level of business asset)
			2.6 The dependence to charity program
			2.7 Owning land and house
			2.8 The accessibility to capital/finance support
			2.9 Trading and commodity prices
			2.10 The involvement in cooperative business/co-group of business)
			2.11 The value of fishermen exchange
3	Socio-Institution (SII)	$SII_j = \left(\prod_{k=1}^{n} CSII_{jk} \right)^{\frac{1}{n}}$	3.1 Policy influence on fishermen
			3.2 Social group dynamics
			3.3 The influence of third parties in the transaction
			3.4 Involvement in resource management efforts and programs
			3.5 Active in service organizations
			3.6 Involvement in fisherman empowerment programs
			3.7 The existence of local wisdom
			3.8 Fisherman card
4	Socio-Infra-structure (SIfI)	$SIfI_j = \left(\prod_{k=1}^{n} CSIfI_{jk} \right)^{\frac{1}{n}}$	4.1 Port / dock / mooring facilities for boat / fishing boats
			4.2 Fish auction
			4.3 Fishing port
			4.4 Fisheries market availability
			4.5 Availability of fisheries facilities and infrastructure providers
5	Social-Safety (SSI)	$SSI_j = \left(\prod_{k=1}^{n} CSSI_{jk} \right)^{\frac{1}{n}}$	5.1 Health protection for fishermen families (for example BPJS)
			5.2 Safety of the cruise
			5.3 Complete navigation on fishing boats / boats
			5.4 Shipping safety knowledge
			5.5 Ship worthiness

Information:

FRI : Fisherman resilience index
SEI : Socio-ecological index
EEI : Economic-ecological index
SII : Social-institutional index
SIfI : Social-infrastructure index
SSI : Social-safety index
$CSEI_k$: The component of socio-ecological index of k
$CEEI_k$: The component of economic-ecological index of k
$CSII_k$: The component of social-institutional index of k
$CSIfI_k$: The component of social-infrastructure index of k
$CSSI_k$: The component of social-safety index of k
n : Number of index components and or strategic parameters (SP)
j : Composite index j from the i.e. regional FRI
k : The strategic parameter of k of the composite index of j.

Table 3. The components of each strategic parameter and each of their indicators and its scoring

Index	Strategic Parameter (SP)	Indicators	Score
Socio-Ecology (SEI)	1.1 Work time allocation	Work time allocation is less than 8 hours	3
		Work allocation is between 8-12 hours	2
		Allocation of working time is above 12 hours	1
	1.2 Knowledge about sustainable resources	Sustainability of resources is used as a code of conduct for arrest	3
		Know the importance of resource sustainability	2
		Not concerned about the sustainability of resources	1
	1.3 The quality of coastal and marine resources	Coastal ecosystems are still good	3
		Coastal ecosystems have started to damage	2
		Damaged coastal ecosystems	1
	1.4 Fishing ground	The fishing ground is fixed and produces a relatively large volume of catch	3
		The fishing ground is fixed and produces a relatively sufficient catch volume	2
		Do not have a fixed fishing ground and relatively enough catch volume	1
	1.5 The volume of harvest per trip per fishermen (fish stock abundance)	Relatively much	3
		Average	2
		Relatively few	1
Ecological-Economics (EEI)	2.1 The conflict of resources economic utilization	There is no conflict	3
		Conflicts occur but can often be overcome	2
		A prolonged conflict occurred	1
	2.2 The flexibility fishermen household	Small family size up to 2 people per family	3
		Medium family size up to 3-4 people per family	2
		Large family size up to more than 4 people per family	1
	2.3 Fishermen income	Earning more than IDR 2 million per month	3
		Earning between IDR 1-2 million per month	2
		Earning less than IDR 1 million per month	1
	2.4 The availability of alternative income	Have other income up to more than 30 percent	3
		Have other income less than 30 percent	2
		Do not have other income	1
	2.5 Degree of independence business (property level of business asset)	Have a business capital of more than IDR. 250 million	3
		Have a business capital of between IDR 100-250 million	2
		Have a business capital of less than IDR 100 million	1
	2.6 The dependence to charity program	Never received government assistance	3
		Less than 30 percent of the assets owned come from government assistance	2
		More than 30 percent of assets owned come from the government	1
	2.7 Owning land and house	Own your own land and house and certified ownership	3
		Own your own land and house but not yet certified ownership	2
		Still contracting or joining a family	1
	2.8 The accessibility to capital/finance support	Easy and can be accounted for (financial institutions)	3
		Easy and less accountable (large basket / capital owner)	2
		Access to capital is difficult	1
	2.9 Trading and commodity prices	Marketing is easy and the price is relatively proportional	3
		Marketing is easy and prices are relatively less proportion	2
		Marketing is difficult and the price is not proportional	1
	2.10 The involvement in cooperative business/co-group of business)	Get involved and get benefits in the cooperative business /KUB	3
		Involved but lacking benefits in the cooperative business /KUB	2
		Never want to be involved in a cooperative / KUB business	1
	2.11 The value of fishermen exchange	Fisherman exchange rate is above 150	3
		The exchange rate of fishermen between 100-150	2
		Fisherman exchange rate is less than 100	1

Table 3. (continued)

Index	Strategic Parameter (SP)	Indicators	Score
Socio-Institution (SII)	3.1 Policy influence on fishermen	The influence of policies can be well adapted	3
		The influence of policies is less well adapted	2
		Policy effects cannot be adapted	1
	3.2 Social group dynamics	Help each other	3
		Compete healthy	2
		Compete against each other	1
	3.3 The influence of third parties in the transaction	Having a good and balanced bargaining position	3
		Having a bargaining position but not balanced	2
		Highly influenced by third parties and does not have a bargaining position	1
	3.4 Involvement in resource management efforts and programs	Actively involved in resource management efforts and programs	3
		Not too intense involved in resource management efforts and programs	2
		Do not want to be involved in resource management efforts and programs	1
	3.5 Active in service organizations	Active in service organizations	3
		Passive in service organizations	2
		Not involved in service organizations	1
	3.6 Involvement in fisherman empowerment programs	Get involved and get benefits in the fishermen empowerment program	3
		Involved but not getting the benefits in the fishermen empowerment program	2
		Never wanted to be involved in a fishermen empowerment program	1
	3.7 The existence of local wisdom	Local wisdom is upheld and implemented effectively	3
		There is local wisdom but it is not effective	2
		There is no local wisdom	1
	3.8 Fisherman card	Have a fisherman card and use it for service purposes	3
		Have a fisherman card but have never used it for the benefit of service	2
		Don't have a fishing card	1
Socio-Infra-structure (SIfI)	4.1 Port / dock / mooring facilities for boat / fishing boats	The facilities function well and provide benefits for fishermen	3
		The facilities do not function well but still provide benefits for fishermen	2
		No facilities / facilities but not useful	1
	4.2 Fish auction	Functioning effectively and providing benefits for fishermen	3
		Not functioning effectively but still providing benefits for fishermen	2
		There are no auctions / although there are but not / does not provide benefits	1
	4.3 Fishing port	There is a fishing port and provides benefits for fishermen	3
		The existence of a fishing port does not provide benefits for fishermen	2
		There is no fishing port that supports fishing activities	1
	4.4 Fisheries market availability	The market is available and beneficial for fishermen	3
		The market is available but the benefits are still lacking	2
		There is no fishing market	1
	4.5 Availability of fisheries facilities and infrastructure providers	Easily affordable prices get services providing facilities and infrastructure	3
		Easy with relatively high prices to get services providing facilities and infrastructure	2
		Difficult to get access to services and infrastructure	1

Table 3. (continued)

Index	Strategic Parameter (SP)	Indicators	Score
Social-Safety (SSI)	5.1 Health protection for fishermen families (for example BPJS)	Fishermen and all members receive health protection from the government	3
		Not all family members of fishermen accept the need for health protection	2
		Fishermen and families do not receive health protection	1
	5.2 Safety of the cruise	Fishermen often get cruise safety advocacy	3
		Fishermen rarely get cruise safety advocacy	2
		Fishermen have never received cruise safety advocacy	1
	5.3 Complete navigation on fishing boats / boats	Fishermen have a modern navigation system	3
		Fishermen have a traditional navigation system	2
		Does not have its own navigation system	1
	5.4 Shipping safety knowledge	Fishermen understand the safety knowledge of shipping	3
		Fishermen do not understand the safety knowledge of shipping	2
		Fishermen do not have knowledge of shipping safety	1
	5.5 Ship worthiness	Have an arrest permit and the feasibility of routine operations being monitored	3
		Has an arrest permit but the feasibility of operations is not routinely monitored	2
		Do not have an arrest permit and are not eligible for surgery	1

Information:

FRI : Fisherman resilience index
SEI : Socio-ecological index
EEI : Economic-ecological index
SII : Social-institutional index
SIfI : Social-infrastructure index
SSI : Social-safety index
n : Number of index components and or strategic parameters (SP)
$CSEI_k$: The component of socio-ecological index of k
$CEEI_k$: The component of economic-ecological index of k
$CSII_k$: The component of social-institutional index of k
$CSIfI_k$: The component of social-infrastructure index of k
$CSSI_k$: The component of social-safety index of k
j : Composite index j from the i.e. regional FRI
k : The strategic parameter of k of the composite index of j.

4. FOLLOW-UP RECOMMENDATIONS AND POLICY IMPLICATION

Indonesian fishermen in each region of the Republic of Indonesia's fisheries management have their own characteristics. Indonesian fishermen are divided into river and or lake fishermen, coastal fishermen, artisanal fishermen, and open sea fishermen. Each of these fishermen can of course be assessed for their resilience according to their place and working area.

Specifically for fishermen who catch fish in Indonesia's coastal and marine areas, they are divided into 11 fisheries management areas. Each fisheries management area also has a unique catchment area characteristics in accordance with the existence and characteristics of the ecosystem contained in each region. Therefore, by using this developed methodology, each fisheries management area will be able to have its own fisheries resilience index value, so that it can facilitate policy makers to mitigate the planning of policies and programs that will be implemented so that they can be adapted to the characteristics the area and value of this fishermen's resilience index.

The assessment of Fishermen Resilience Index (FRI) in Indonesia can be done through primary and secondary surveys, especially to get a questionnaire based on criteria and index algorithms that are carried out throughout the coastal area to get a detailed picture of the potential resilience of fishermen. Globally, Fisheries Management Area of Republic of Indonesia (FMA RI) usually covers several provinces which administratively cover several coastal regencies/municipal areas.

The survey could be conducted in all coastal sub-districts of the area concerned by taking a sample of 20 percent of the coastal villages in the district/city that were spatially distributed. Furthermore, from the selected coastal villages interviews were conducted with a minimum of 10 percent of fishermen available to obtain a

proportional picture that could represent the overall population of fishermen who were against the study area. In the diagram, the complete data collection index of fishermen's resilience can be seen in Figure 4.

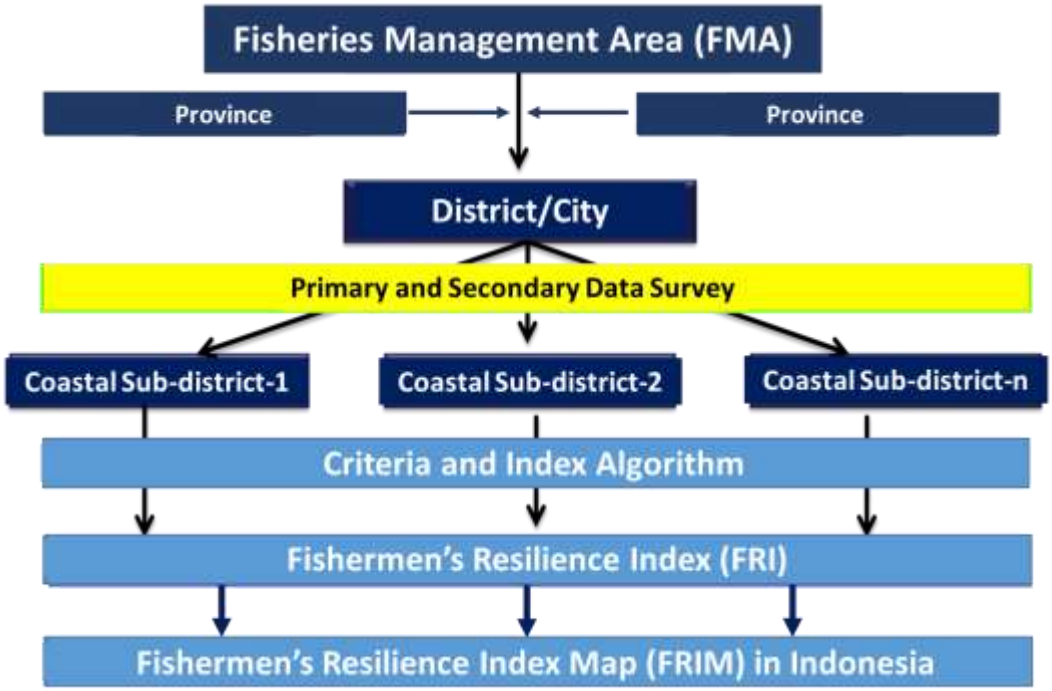

Figure 4. The framework for fishermen's resilience index map (FRIM) in Indonesia

After the fisheries resilience index study was conducted in 11 fisheries management areas, policy makers can make efforts to mitigate policies by following a logical framework approach that is adapted to the conditions and characteristics of each region.

Adrianto (2004) states that planning can be characterized as a starting point of the implementation of a management program. The planning process can be carried out using logical framework analysis tools, more commonly known as Logical Framework Analysis (LFA). LFA is an approach that can be used as a tool to plan a policy / strategy / program / activity that was prepared with no intention to replace the policy / strategy / program / activity itself. The LFA is structured to assist planners and decision makers in the context of achieving: (1) structured design or planning processes; (2) increased planning transparency; (3) increasing the participation of all stakeholders in the planning itself; (4) consistent planning strategy; and (5) increased flexibility of the planning framework.

Furthermore, Adrianto (2004) states that in the LFA framework, there are at least two important elements that are the basis for development planning, namely (1) the analysis phase); and (2) elements of the planning phase (planning phase).

In the analysis phase, there are 3 (three) types of analysis that are at least the basis of planning, namely (1) situation analysis which includes an analysis of stakeholders, key and strategic problems, constraints and opportunities, and determination cause-and-effect relationships at each level of the problem; (2) objective analysis, namely by establishing goals to be achieved from the planning and identified problems; and (3) strategic-policy analysis by identifying several alternative policy-strategies to achieve the stated goals.

Meanwhile, in the planning phase there are three important elements to do, namely (1) log frame (logical framework), namely by defining the structure of policies / strategies / programs / activities, testing the internal logic related to the structure of the activity, and defining methods and costs for implementing activities; (2) schedule of activities (activity scheduling), namely determining the order of work sequence in the context of activity planning; and (3) resource scheduling, namely identifying the budget and funding sources after the schedule of activities is carried out. Diagrammatically, the components of the analysis and planning stages can be seen in Figure 5.

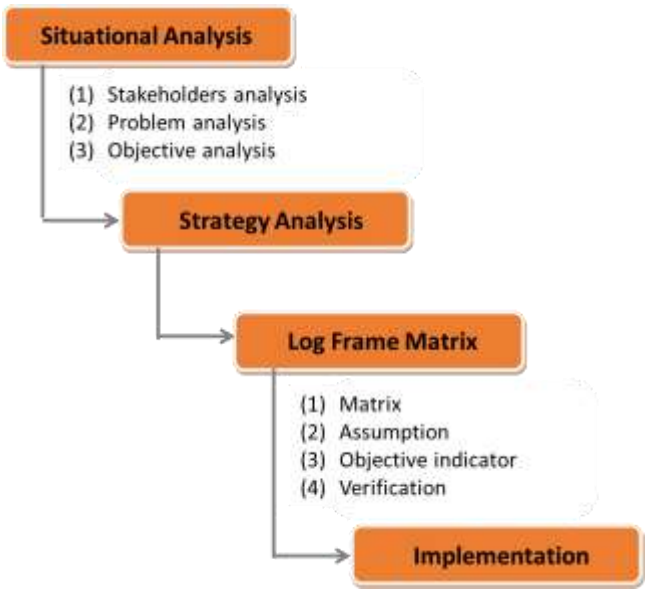

Figure 5. The framework for defining policy mitigation based on fishermen's resilience index map (FRIM) in Indonesia

Adrianto (2004) states that the most important part of the LFA process is the compilation of the Log Frame Matrix which is a derivation of strategy analysis. The concept of the log frame matrix is based on an analysis of the relationship between objectives, strategies and external factors determined through valid assumptions about the program of activities being evaluated. Errors in making assumptions are common mistakes in program planning and evaluation. Table 4 below presents the format of the Log Frame matrix used in the evaluation of LFA-based programs.

Table 4. Example of log frame format in LFA

Component	Verifiable indicators	Verification method	Assumptions used
General objective			
Special objective (program goal)			
Outcome/ output			
Input/ activities			

Source: Adrianto (2004).

5. CONCLUSION

The developed algorithm model can show the character of an index compilation, however it still requires improvements that can be designed based on the test results of the model application. Therefore, as a model, this algorithm needs to be tested publicly through the model application review path in several areas as an effort to justify and calibrate the model.

After the application test and model calibration process, the algorithm for determining the fisherman resilience index (FRI) needs to be translated into a legal guide, so that it can become a reference and guide for the implementation of the index determination later. The resulting index can be used as a reference base for vulnerability priority based policy mitigation. This means that the first focus of mitigation is carried out on areas that have a resistance value less than 0.5000 or close to the index value equal to zero.

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