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RESEARCH ARTICLE

DINAMICS OF SUSTAINABLE WELFARE FISHERIES BASED ON TUNA FISH SENDANG BIRU, MALANG (DINAMIC SYSTEM APPROACH).

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Abstract

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This study was developed as a dynamics system model which is integrated tuna stocks, social economic and policy sub models. This model was developed based on historical data, than development into three development scenarios: with fish cact limitation, limitation by sustainable yield (MSY) limitation by maximum economic yield (MEY) and open access equilibrium (OAE). System dynamic modeling was conducted to analyze sustainable tuna and sustainable income of tuna fishermen based on various points of view to get the better management of sustainable tuna fisheries.

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Introduction:-

Indonesia is the largest archipelagic country in the world, with 2/3 of its territory being a sea area with a total of around 17,504 islands and a coastline of 81,000 km. The vast potential of marine resources is stored in the content of biological and non-biological resources starting from inland waters to the Indonesian exclusive economic zone. The biggest potential of marine biological resources is fisheries. In the last 10 years, it has been shown that fisheries exploitation and exploration in Indonesia shows a very significant increase, but not followed by an increase in catch, this has an impact on the welfare of fishermen kicked in blue

Table 1:-Level of Utilization of Tuna in SendangBiru

No	Tahun	Production	Total Allowable Catch(Kg)	Utilization Level (%)
1	2005	10.893.272	9.831.881	111
2	2006	12.558.335		128
3	2007	13.884.315		141
4	2008	13.169.215		134
5	2009	12.131.567		123
6	2010	11.769.855		120
7	2011	9.981.365		102
8	2012	11.861.459		121
9	2013	14.465.005		147
10	2014	11.283.575		115
11	2015	11.042.125		112

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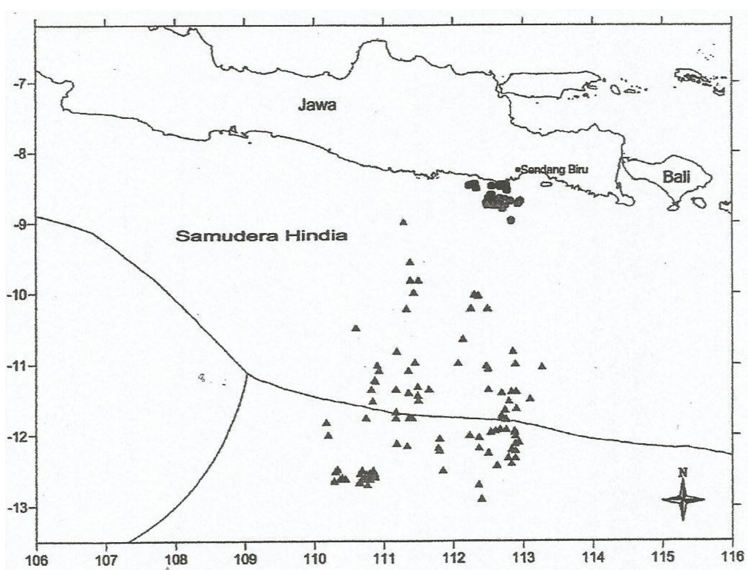
Research purposes:-

Based on this background, an effort is needed to maintain the sustainability of fisheries resources so that they are sustainable from the environmental side, economically beneficial and also beneficial in the long term by creating sustainable fisheries management in SendangBiru to create a sustainable fishermen's welfare. For this reason, a study or research is needed with the system modeling approach. One technique that can be used is through a dynamic system approach

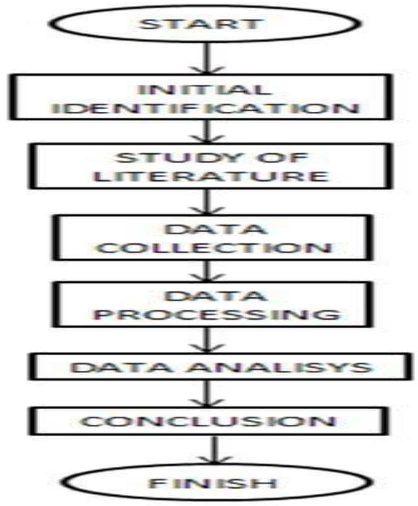
Research Methods:-

The study was conductedon July until September 2018 in the SendangBiruwaters, Malang. The SendangBiru's coast which is located in Tambakrejo Village, SumbermanjingWetanSubdistrict, Malang Regency is directly facing the Fisheries Management Area (WPP) of 573 that is the Indian Ocean which is rich in Large Pelagic Fish. Based on its geographical conditions, SendangBiru is in the position of 080 08^0 22' 15" LS dan 112^0 47' 30' BT. Fisheries in the waters of SendangBiru is a sub-sector that contributes a lot to Malang Regency's Regional Revenue (PAD) which has shown an increase in the number of production in each year. This development shows that the potential of fisheries resources in the Blue Waters region needs to be managed properly, especially tuna fisheries resources which are large pelagic fish commodities that have high economic value. The fishing fleet based at IPP Pondokdadapconsists of a local and andon fleet with a range of weights between 9 GT-30 GT. The Lifeboat fleet is administratively more orderly than the other fleets, equipped with sailing approval letters, letters of arrival report, list of ship's men, Log Book of catches, operational feasibility letters (SLO), minutes of inspection of ships, domestic measurement letters, Fishing License (SIPI), and Fishery Business License (SIUP). The fishing gear used by the lifeboat fleet is stretch fishing rods (tonda fishing rods). In fishing activities other than using fishing rods also use FADs as a tool. The catchment area of the lifeboat fleet based at IPP Pondokdadap, SendangBiru is around the FADs, this area is at 09 ° - 12 ° LS and 110 ° - 11 starting from 3 ° East waters. Figure 1)



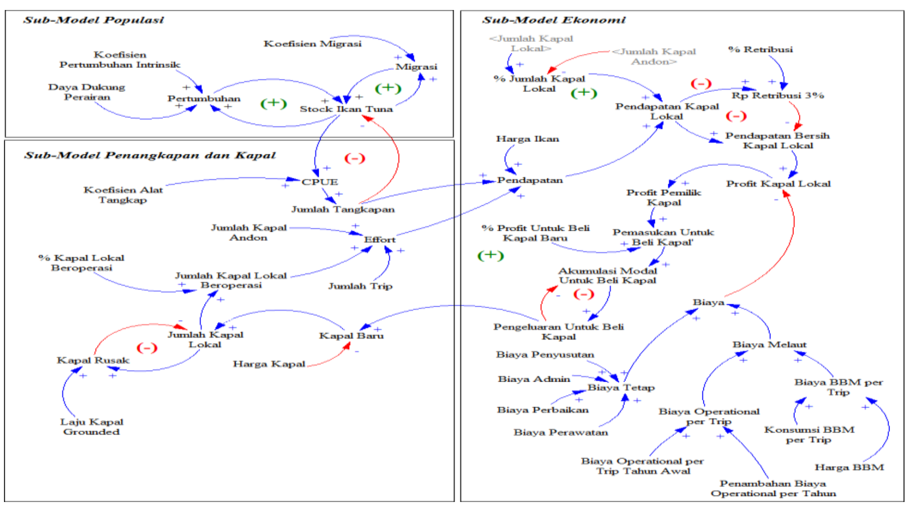
Picture. 1:-Of the Tuna Catching Spot of SendangBiru Map
(**Source:** LPPT 2014 Annual Report)

To solve the problem's reseacrh, there are steps needed and determined to describe the approach and problem model. The steps taken are :



Causal Loop Diagram:-

Causal loop diagram is a conceptualization of a system that describes a causal relationship between variables that interact in the system. The relationship with a positive sign indicates another variable increase, and vice versa. While the relationship with a negative sign indicates an increase in a variable will result in a decrease in the other variables and vice versa. Causal loop diagram consists of 3 sub-models that are sub population model, sub-model of catch and ship and sub-economic model in this study illustrated in Figure. 2.



Picture. 2:-Causal Loop Diagram

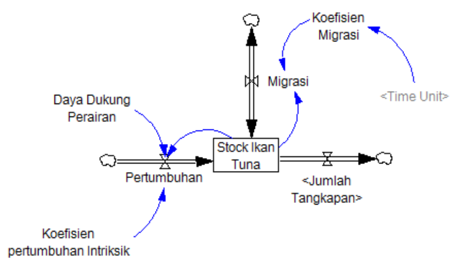
Input - Output Diagram:-

Input - output diagram is used to describe the input and output variables of the system schematically, in input - output diagrams, variables are classified into controlled inputs and uncontrolled inputs, controlled output, uncontrolled output and environment. Input - output diagram describes the desired output from modeling, inputs that can be changed to achieve optimal output and other factors that cannot be changed but can affect the desired output.

Stock and Flow Diagrams Organization:-

Organizing stock and flow diagrams begins with a reference to the causal loop diagram that has been made before, Stock and Flow is made to describe the interaction between variables according to the logic of structure in dynamic modeling software. Stock and Flow is a tool that can be used to simulate the dynamic behavior of the system with the existence of a sustainable fisheries management policy scenario towards the income dynamics of tuna-based fishermen in Sendangbiru, Malang.

Population Sub-Model:-



Catch and Ship Sub-Model:-

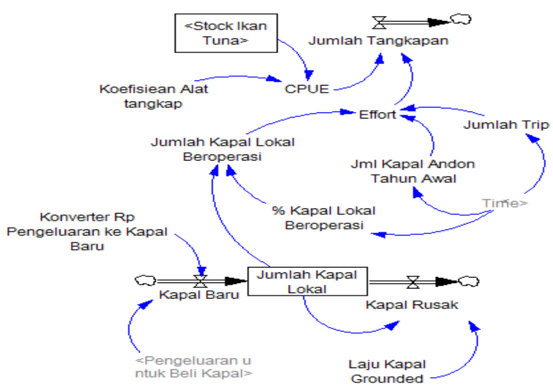
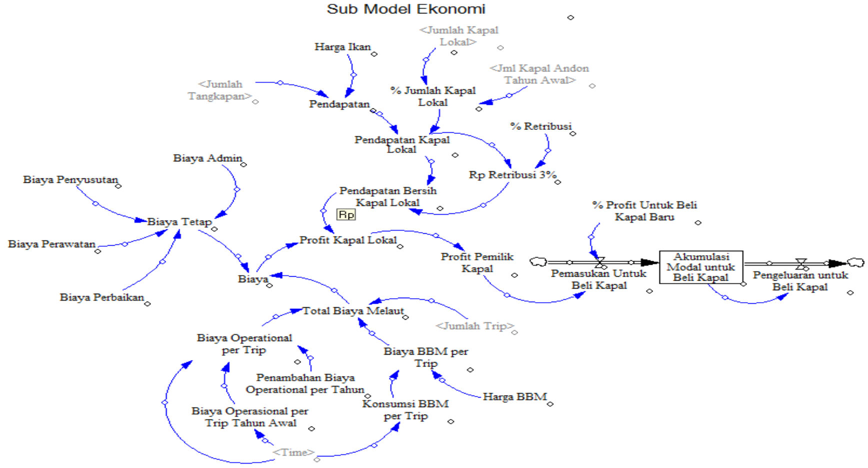


Figure 3:-Stock and Flow Catching and Ship Sub Models

Economic sub-model:-

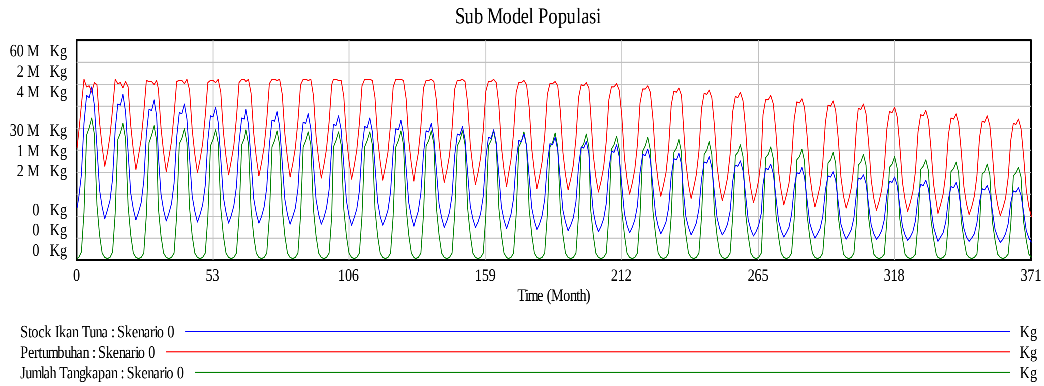


Picture. 4:-Stock and Flow Economic Sub-Model

Verification and Validation Model:-
Verification and validation Model is done to ensure that there are no errors in the model and the model can be simulated according to the initial purpose of the model construction.

Result:-

And AnalysisFish Population Sub-Model:-
In the sub-model of fish stocks, the main focus is the fish stock response variable which is an ecological aspect of sustainability indicators. On graph 4, It can be seen that tuna stocks tend to decrease every year this is because the effort has increased every year, an increase in effort can be seen in graph 4. Which has an impact on the decrease in the number of obtained CPUE? Growth follows the pattern of tuna stock, when the stock moves down, growth also falls, followed by the number of catches that also drop until the last year of the simulation.



Graph .1:-Simulation of the Fish Population Sub Model

Catch and Ship Sub-Models:-
In the sub-fishing model, the main focus of the response variable is CPUE (catch per unit effort). In graph 4. It can be seen that the CPUE value always decreases every year. Decreasing CPUE caused by an increase in effort can indicate overfishing in these waters.

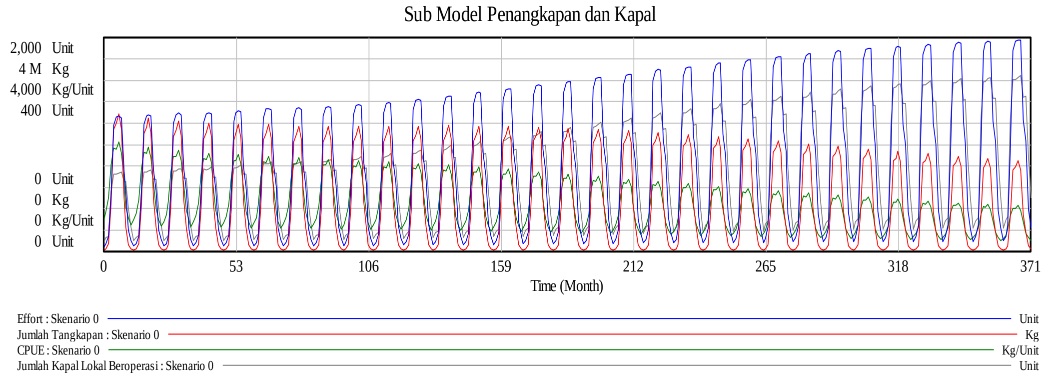


Chart. 2:-Simulation of Catching and Ship Sub-Models

Fisherman Economic Sub-Model:-
The main focus of the fisherman's economic sub-model variable is profit which is an indicator of the economic aspects of sustainable fisheries. A small or minus profit can be interpreted as overfishing in that area. With a large effort, the costs required are also large while the resulting catches are small so it is not comparable between the cost of fishing and the results obtained. In graph 4.it can be seen that even though the number of catches decreases each year, the profit of fishermen actually increases, this is inseparable from the influence of the price of fish that continues to rise every year.

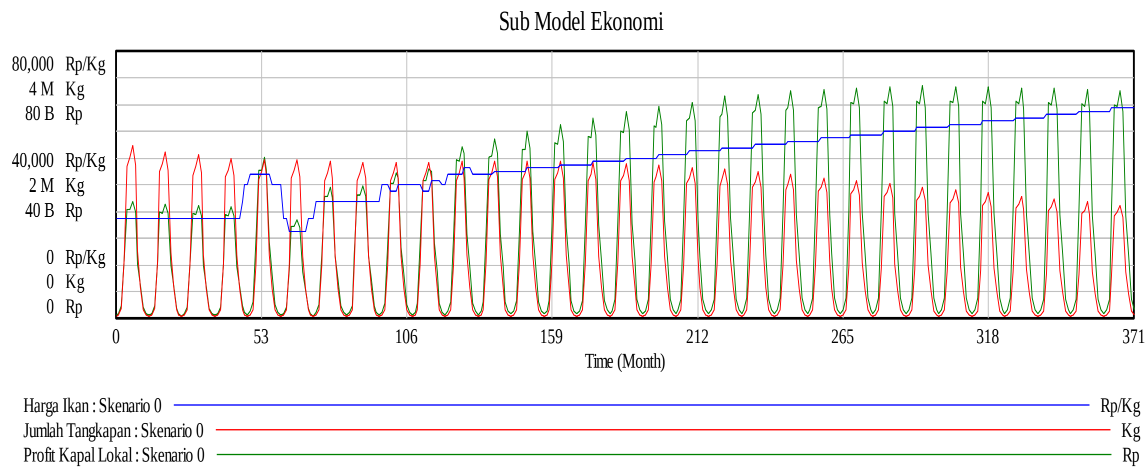
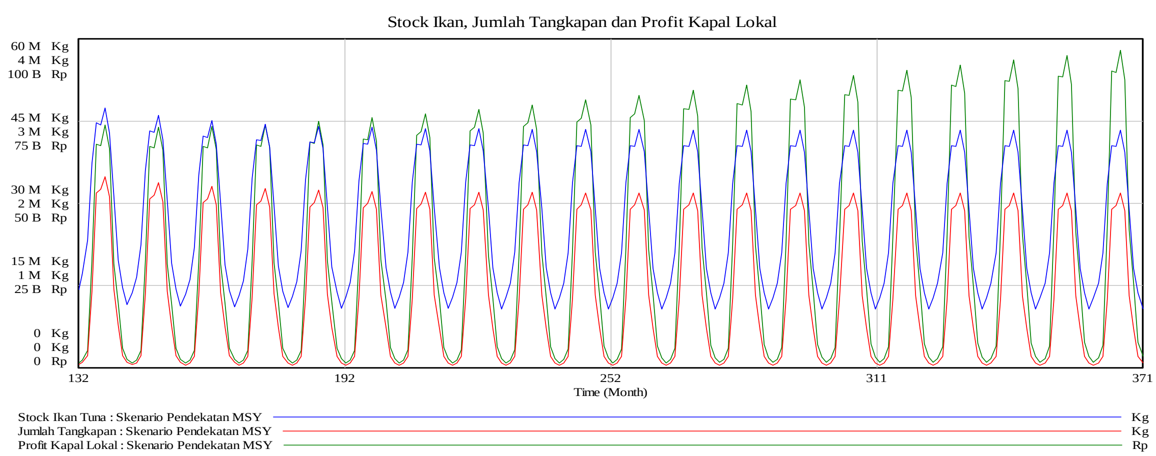


Chart. 3:-Simulation of the Economic Sub Model

Effort Restriction Policy with MSY Approach Scenario:-

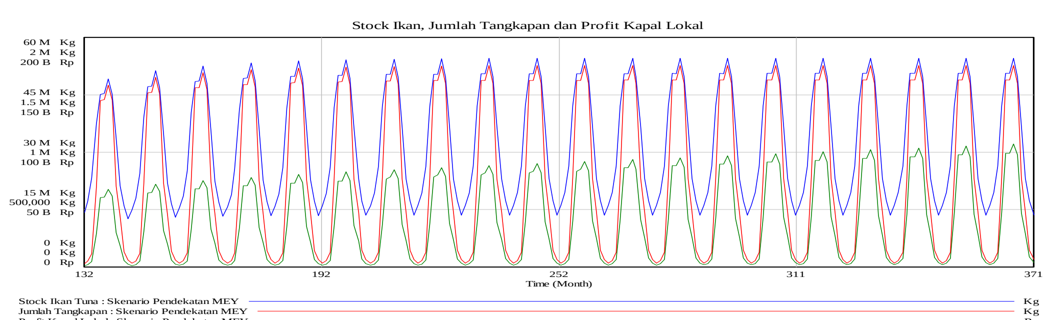
In this scenario, an effort treatment is applied with the MSY approach with an effort value of 7,031 Units. To get the effort this amount is first set up in the simulation model, so that local and Andon ships which must operate according to the simulation model are obtained by 211 local ships and 72 Andon Ship.



Graph .4:-Simulations of Effort Restriction Scenarios with the MSY approach

Effort Restriction Policy with MEY Approach scenario:-

In this scenario, an effort treatment is applied with the MSY approach with an effort of 4,893 units, this effort can be carried out by 186 units of local ships without involving the operation of the Andon Ship



Graph 5:-Simulation of Effort Restriction Scenarios with the OAE Approach

Effort Restriction Policy with OAE Approach Scenario:-

In this scenario, an effort treatment was applied with an OAE approach with an effort value of 9,786 Units. The number of local ships and Andon operating in this scenario is 211 units and 205 units.

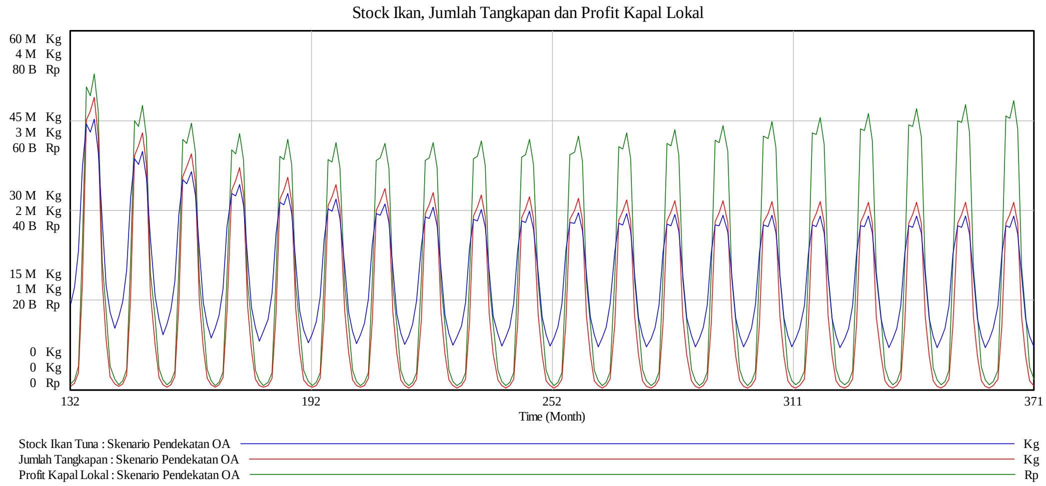


Chart .6:-Simulations of Effort Restriction Scenarios with the OAE Approach

Comparison of Simulation Results with Various Approaches:-

In graph 5.6 above, for the number of tuna stocks in the MEY and MSY scenarios relatively stable throughout the year, while in the OAE scenario and existing conditions, tuna stocks tend to decline throughout the year up to 2035. The decline in the OAE scenario is due to as much effort as 9,786 units, this effort exceeds the optimistic effort which amounted to 7,031 units, causing the tuna stock to decline from year to year

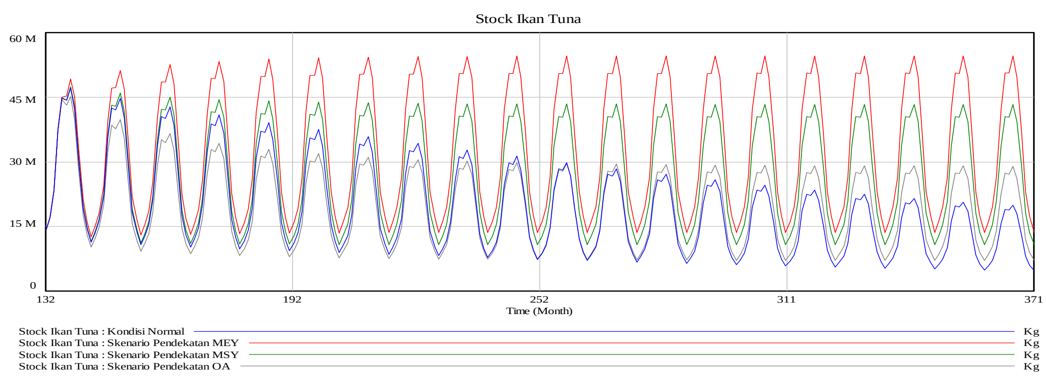
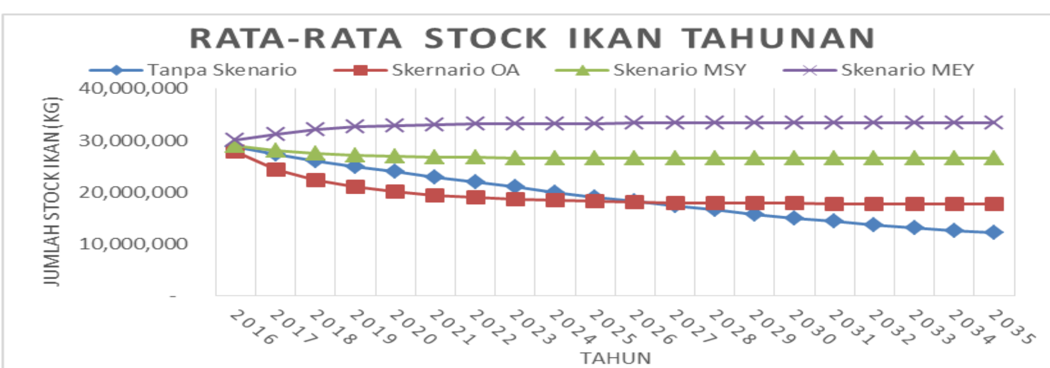


Chart .7:-Comparison of Scenarios for Tuna Stock Conditions



Graph .8:-Comparison of annual fish stocks

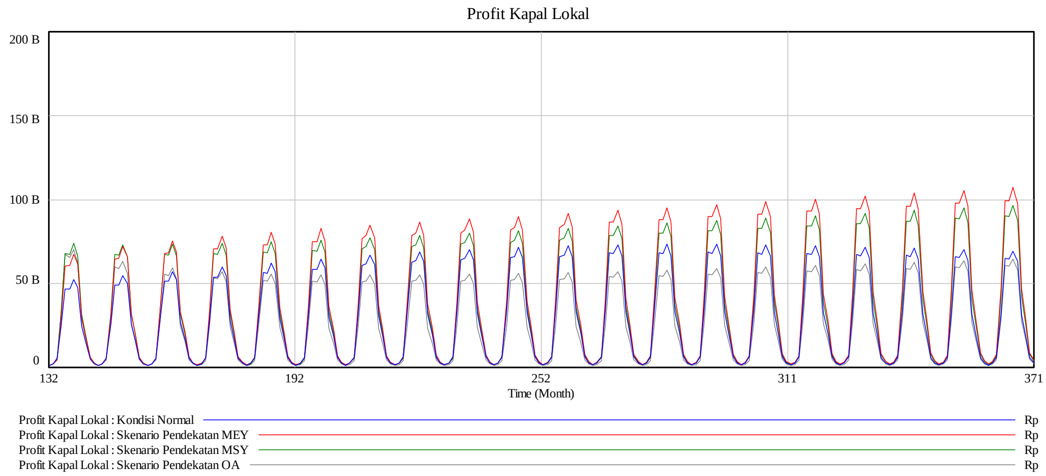


Chart .9:-Comparison of Scenarios on Local Ship Profits

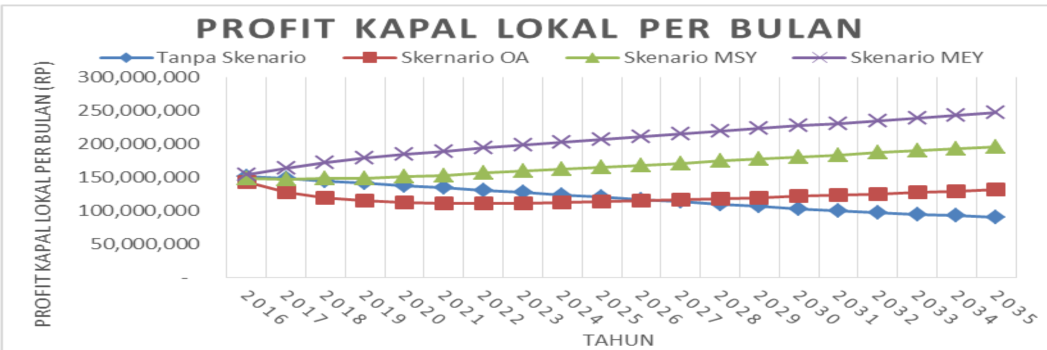


Chart .10:-Comparison of Local Ship Profit

Selection of the Best Scenario:-

The current condition is there are 211 Local Ship and 200 Andon Ship that operating in SendangBiru waters, if the MEY policy is implemented, they must ground 35 unit lifeboats and prohibit all andon ships from operating in blue springs, so even though they provide economic benefits the highest policy is difficult to do in SendangBiru Waters because it can cause social turmoil in the community, if applying the OAE policy, all ships currently in SendangBiru Waters can operate but with little profit and the lowest level of tuna stock, so that the most appropriate policy applied in blue kick now is sustainable fisheries management with the approach of MSY by operating local ship as many as 211 units and limiting andon ship to a number of 72 units, although from profits not as high as the MEY approach, the MSY approach can accommodate a variety of interests at SendangBiru Waters.

Conclusions:-

In the simulation of the existing conditions the profit obtained by fishermen has decreased every year. Because the number of fish stocks and CPUE has decreased due to fishing businesses that continue to increase throughout theyear. To keep fish stocks from decreasing every year it is necessary to limit fishing efforts, in sustainable fisheries management there are three approaches to catching effort as follows:

1. MSY approach, fish stocks are at the stock level of 43,358,028kg with profit of Rp. 2,791,481,508, - with the limitation of the number of vessels operating 211 units of local ships and 72 units of andon ships.
2. The MEY approach, fish stocks are at the stock level of 46,704,608kg with profit of Rp. 3,008,297,848, - with the limitation of the number of vessels operating 211 local local ships and 41 andon vessels.
3. The OAE approach, fish stocks are at the level of 13,655,449 kg with a profit of Rp. 866,349,906, - with the limitation of the number of vessels operating 211 local vessels and 354 units of andon ships. The dynamic system model that has been built in this study can be used to realize sustainable fisherman welfare by maintaining sustainable tuna stocks at stock levels 46,704,608

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